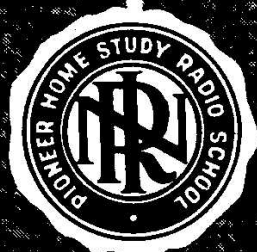


SERVICING RECORD CHANGERS

48RH-2



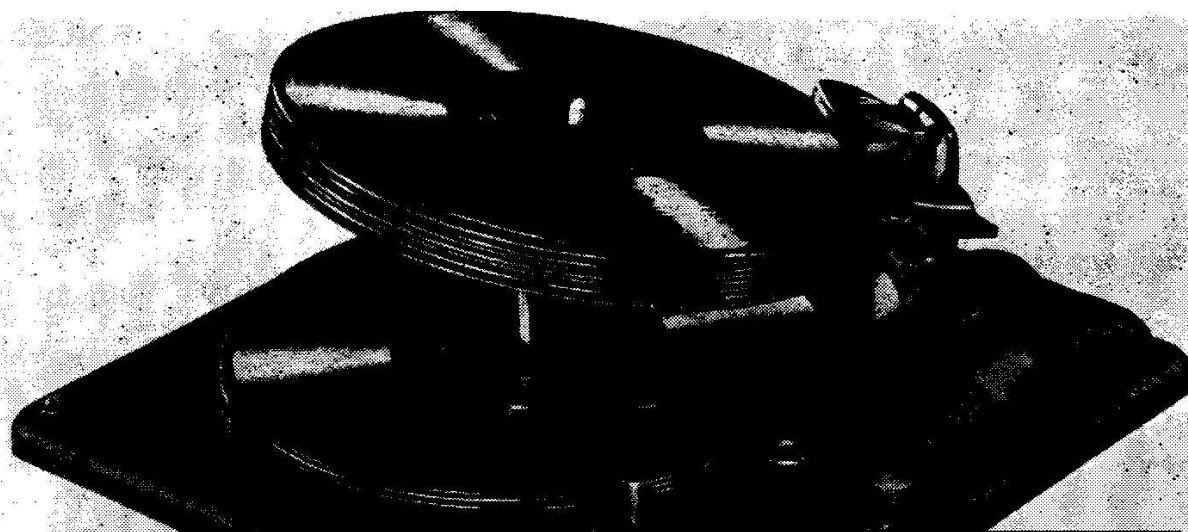
NATIONAL RADIO INSTITUTE
WASHINGTON, D. C.

ESTABLISHED 1914

STUDY SCHEDULE NO. 48

For each study step, read the assigned pages first at your usual speed, then reread slowly one or more times. Finish with one quick reading to fix the important facts firmly in your mind. Study each other step in this same way.

- ☐ 1. Introduction Pages 1-4
The general characteristics of non-mixing and mixing record changers are described in this section.
- ☐ 2. A Study of Changer Functions Pages 4-24
Here you study each of the operations of a record changer in detail.
- ☐ 3. Servicing Record Changers Pages 24-28
This section shows you how to service a defective changer.
- ☐ 4. Pickups and Their Servicing Pages 28-32
A brief description of the 3 types of pickups and instructions for servicing them are contained in this section.
- ☐ 5. Motors and Their Servicing Pages 33-35
This section contains servicing instructions for the popular types of phonograph motors.
- ☐ 6. Microgroove Records Pages 35-36
The newest developments in records and their players are briefly discussed here.
- ☐ 7. Answer Lesson Questions and Mail Your Answers to NRI for Grading.
- ☐ 8. Start Studing the Next Lesson.



SERVICING RECORD CHANGERS

AUTOMATIC record changers are the logical outgrowth of the return to popularity of phonograph records. Before the advent of radio, the phonograph was very popular. Then, for a time, the radio supplanted the phonograph in the home. Gradually, however, electrical record players that operated through the radio receiver or had built-in amplifiers became increasingly popular. As you know, these record players consist of a motor-driven turntable and a pickup arm. The latter, through either an electromagnetic pickup or a crystal pickup, converts the modulation on a record groove into an electrical signal that can be amplified and reproduced by an audio amplifier and loudspeaker.

You are undoubtedly familiar with the method of operation of such a record player. You place the desired record on the turntable, turn on the power, and lower the pickup arm into position on the outside edge of the record. When the record is finished, you remove the pickup arm, turn off the power, and remove the record, either

to turn it over or to replace it with another. You can play any size record that is 12 inches or less in diameter—the standard 10-inch or 12-inch diameter records, or the smaller “specials.”

The automatic record changer is designed to make it easier to play records. In all of the automatic record-changer systems, a collection of records is arranged in the order in which they are to be played. These records are stacked in some storage system. When the device is turned on, a record moves to the playing turntable, and the pickup arm is automatically placed on it. At the end of the record, the pickup arm is removed and the next record is put into playing position. This operation is repeated until all have been played. Most changers handle enough standard records to play for more than half an hour before it is necessary to handle the records.

Ordinarily, automatic record players play only one side of a record before going to the next record. As a result of the widespread use of such record changers, most symphonies and other selections requiring more than a single

Photo above, Courtesy Webster-Chicago Corp.



Courtesy Olympic Radio Corp.

A typical record-player-radio combination. A single record is played at a time.

record are arranged in a sequence so that side 1 is on the first record, side 2 is on the second record, side 3 on the third, etc. Then, by turning the records over, you can run the stack in opposite order through the succeeding sides to the end of the performance.

Of the common record-changer types, there are two basic varieties—the non-mixing and the inter-mixing. In the non-mixing types, a control is set so that either 10-inch records or 12-inch standard records may be played, but not the two sizes mixed. In the inter-mixing kind, both 10-inch and 12-inch standard records can be mixed in any order and the machine will automatically play them properly.

There is a third kind of record changer that is designed to play both sides of a record. So few of these have been made, and they are so complex, that we shall not describe them in this Lesson. However, the following information on the two more common basic types will help you in understanding how a two-side player should work. If you should get such a player to service, you can always consult the manufacturer's instructions.

THE NON-MIXING CHANGER

The most popular record changer is the non-mixing type, because it is somewhat less complex in its design and operation and therefore less expensive. Let's run through the operation cycle for a basic non-mixing changer:

First, a group of records, all of the same size (either 10-inch or 12-inch), are selected. Changers have different capacities, but most of them will play from eight to ten 12-inch records or ten to twelve 10-inch ones. Of course, any smaller number can be used at a time. Once the records are selected and have been placed in the order in which they are to be played, they are put into the storage mechanism.

The control switch or lever is now placed in the position corresponding to the record size. On many machines, this act also automatically turns on the changer mechanism.

When the changer starts to operate, the first record is dropped into playing position on the turntable. At the same time, the pickup arm is lifted from its rest beside the turntable and moved over the record, which by now is revolving. A positioning mechanism stops the pickup arm and lowers it so that the needle is on the outside plain edge of the record. Gravity, a spring, or the take-in groove on the record now swings the needle into the first playing groove.

To act in this manner, the changer must have some mechanism capable of separating one record from the rest. It must also contain a mechanism that can lift the pickup arm from its rest, swing it to the proper position, and then lower it onto the record. Once the pickup arm is placed on the record, it must be free to follow the record grooves. Therefore, the mechanism that moves the pickup arm must re-

lease it completely while the record is playing, then regain control of it when the record is finished.

The eccentric groove cut as the last groove on a phonograph record is almost always used to make it possible for the pickup arm to be brought under control again. This groove is shaped with respect to the spindle about which the record revolves so that the pickup arm, when it engages the groove, is forced to move rapidly back and forth. A tripping mechanism is then actuated, either because of the back and forth motion or because the pickup moves faster in this groove or because the pickup is brought close to the spindle. Once the trip is actuated, the pickup arm is lifted from the record, then swung to the side out of the way. The next record in the group is now dropped into playing position. Once there, the pickup arm is returned over the edge of this record and dropped into playing position.

When the last record in the group has been dropped and played, some changers automatically move the pickup arm to the side and turn off the mechanism. Others repeat the last rec-

ord over and over until they are turned off.

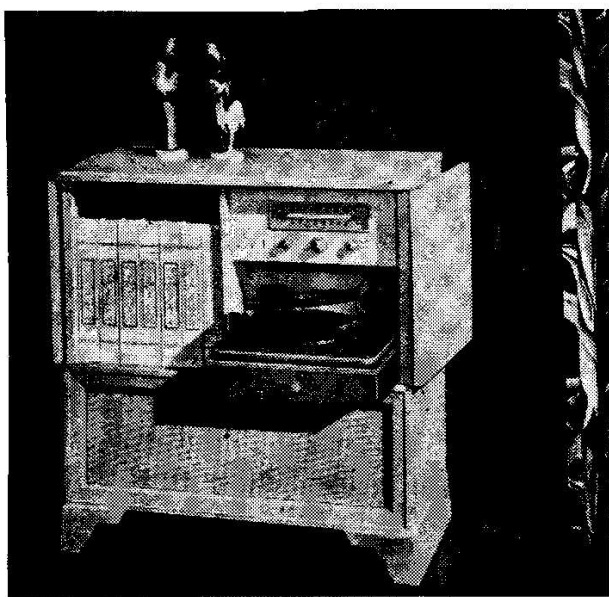
In most cases, the control lever has a reject position so that you can reject any record in the group you don't want to hear. Pushing the reject lever to the proper position actuates the trip that the pickup arm normally actuates at the center of the record. This automatically causes the mechanism to pick up the arm from whatever position it is in and play the next record.

If you want to play 12-inch records when 10-inch ones have been played before, or vice versa, put the proper records into position and move the controls to the appropriate position. This automatically moves a stop so that the pickup arm will drop in the right position. The remainder of the change cycle is identical with the one we just described.

INTER-MIXING CHANGERS

In an inter-mixing changer, 10-inch and 12-inch records can be mixed up in any order in the storage system. When the mechanism is turned on, and the first record is caused to drop, the dropping mechanism makes use of a system of fingers or feelers to determine the size of the record that dropped. Automatically, as a result of this, the stop for the pickup arm is set to the proper position so that the arm will land on the plain outside edge of the record. The playing cycle is identical with that of the non-mixing kind except for this additional automatic feature of the device's determining the record size and setting the pickup arm to drop in the proper position.

All changers, whether non-mixing or inter-mixing, can be played manually by setting the control lever to the proper position. Doing so takes the record dropping mechanism out of operation, and individual records can



Courtesy Bendix Radio

Automatic changers are generally used in console combinations like this.

be placed on the turntable and played just as on any single record player. This operation is necessary when any of the non-standard record sizes, such as certain children's records, are to be played.

From the foregoing you can see that even the simplest record changer must be rather complex. It must separate one record at a time from the storage system and place this record on the turntable. It must lift the pickup arm, move it into position, and lower it onto the record. At the end of the record, it must remove the pickup arm so that the next record can be dropped. If it is an inter-mixing changer, it must determine the size of the record and from that properly place the pickup arm.

(Incidentally, some manufacturers refer to the pickup arm as the "tone arm.") Finally, at the end of the group of records, it must either cut itself off or repeat the last record.

All of these operations are performed by a mechanical system driven by the same motor that operates the turntable. In a mechanical system as complex as this, there are almost endless possibilities for variations. In fact, a great many variations have been designed—far more than we can hope to cover in this one Lesson. We shall describe several of the most common record-changer mechanisms; studying these will make it easier for you to understand any other types you may meet.

A Study of Changer Functions

Rather than try to study record changers as an entirety, we shall break down their operations into separate functions. This study of individual actions is desirable because it will show you how to concentrate on one particular action at a time. This is usually necessary in servicing these devices, because, in most instances, only one particular operation of the changer will be out of order. If you know how that operation should be carried out, it will be much easier for you to see just what adjustments are necessary to correct the difficulty.

RECORD PLAYING

Let's start our study of a changer with one record on the turntable and the pickup arm on this record in a playing position. This is a logical place to start, because none of the changer mechanism is in operation. The motor is revolving the turntable and the record, and the pickup needle is following

the record groove. To permit the needle to track properly on the record, the pickup arm is freed from the changer mechanism as much as possible.

The conditions while the record is being played are shown in Fig. 1A. The pickup arm is gradually approaching the center hole of the record because the spirally cut playing groove of the record gradually draws the needle toward the center hole. For several reasons, this spiral groove cannot be continued right up to the middle of the record. The most important reason is that the groove velocity would be entirely too high for the needle to follow the variations. Therefore, the actual recording ends about two inches from the center spindle. The recording is followed by a few more turns of the spiral groove containing no recording, then the last turn of the spiral groove feeds into an eccentric groove.

As shown in Fig. 1A, this eccentric groove is off-center with respect to the

center hole—the distance W is less than the distance X . In Figs. 1B, C, D, E, F, and G, we have shown what happens when the pickup needle enters the eccentric groove. Because this groove is off-center, the pickup arm is rapidly brought in toward the center spindle as shown in B, C, and D. Then, as the groove continues its rotation, the pickup arm is moved rapidly away from the center spindle. In other words, in E, F, and G, the direction of movement of the pickup is reversed from the normal direction that it has had throughout the playing of the record. This eccentric groove is endless, so the pickup arm oscillates back and forth in this same manner until it is taken from the record either by hand or by the record changer mechanism. As we said earlier, this motion of the pickup arm in the eccentric groove is used to actuate the trip mechanism that allows the changer mechanism to regain control of the arm.

TRIP MECHANISMS

Because the pickup arm is forced to move close to the center spindle by the eccentric groove, some trip mechanisms

are arranged to trip when the pickup arm gets close enough to the center spindle. Others depend upon the fact that the motion of the pickup arm is reversed during a portion of the eccentric groove travel. Still others depend upon the velocity at which the pickup arm moves toward the center spindle. We'll describe all types.

Fig. 2 shows how the motion of the pickup arm is conveyed to the trip assembly. The pickup arm is mounted on a hub that is fastened to a hollow shaft. The weight of the pickup arm is carried on ball bearings above a support post that is a part of the motor shelf (or motor board, so called because the motor is suspended from it.)

Attached to the end of the hollow shaft is a trip lever. This may be an individual lever, or may be part of the arm crank that is used to move the pickup arm back and forth when the automatic mechanism is operating. In any case, as shown in B, a motion of the pickup arm causes a similar motion of the trip lever underneath the motor board.

We cannot have a heavy trip lever, because the pickup arm, while playing the record, must be held back as little as possible so that it can easily follow

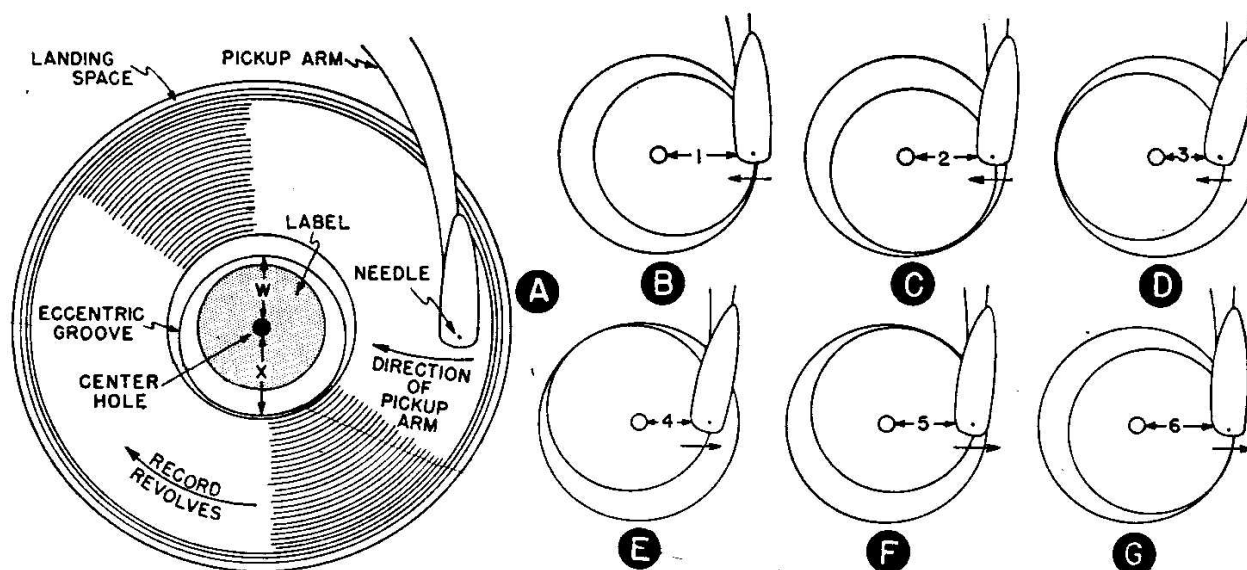


FIG. 1. How the eccentric groove on a record swings the pickup arm in and out at the end of a record.

the spiral groove on the record. Therefore, the trip lever is an exceedingly lightweight arm that is used to actuate another arm or lever, thus starting the record-changing operation.

Incidentally, in a number of our drawings, we shall look down upon the operation as if we could see through

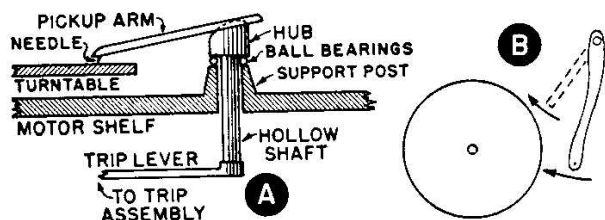


FIG. 2. How the trip lever is attached to the pickup arm.

the motor shelf from the top of the turntable. This helps in seeing just what goes on, but you must remember that the action will be reversed when you are watching the parts from underneath. We are also going to show some drawings of the mechanisms viewed from underneath so that you can become familiar with their appearance in this orientation.

Eccentric Trips. Now that you have a general idea of how the pickup arm can move a trip lever, let's see how the trip lever can be used to start the change action when the pickup needle gets to the eccentric groove. Fig. 3 shows one of the systems that operates when the pickup arm reverses its normal motion. As shown here, the arm shaft connects to a trip lever. At the end of this lever is a trip pawl. The pawl swivels on a bearing, and a spring holds a stop on the end opposite the finger against a cut-out in the trip lever.

While the record is playing, the normal motion of the trip pawl is to the left in this figure. We are looking upon this action from the top. During most of the playing of the record, the trip pawl is not even engaged with the

teeth on the ratchet lever. However, as the end of the record is approached, the trip pawl engages the teeth on the ratchet lever. The spring holding the trip pawl is relatively weak, and the direction of the trip lever mechanism is such that the trip pawl tends to slide over these teeth (Fig. 3B). As long as it moves to the left, it will merely slide over the teeth. As the spiral groove brings the pickup arm closer and closer to the center, this pawl moves along tooth after tooth of the ratchet lever.

When the pickup arm enters the eccentric groove, it will move in the opposite direction during a portion of the rotation, as you learned from Fig. 1. When the motion is to the right, the trip pawl cannot escape the teeth. Therefore, the trip pawl is rotated toward a position in line with the trip lever (Fig. 3C). This increases the distance the end of the pawl projects beyond the trip lever. The pawl then forces the toothed end of the ratchet lever away from the trip lever. (The distance E in Fig. 3C is greater than D in Fig. 3B; and since the trip lever can-

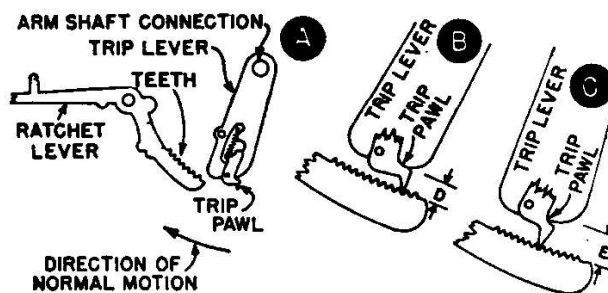


FIG. 3. One trip mechanism.

not shorten, the ratchet arm is forced to move away from it.) The movement of the ratchet lever releases the mechanism, as we shall show a little later.

Another eccentric groove trip is shown in Fig. 4. This time we are showing the view as you would see it from underneath the record changer, so the direction of the trip lever is reversed. In this system, a trigger is held

by spring pressure against a trigger ledge on the ratchet arm. If the end of the ratchet arm with the teeth is pushed upward, the trigger can escape from the trigger ledge, allowing it to drop downward and thus move the "bell crank" to engage the changer mechanism. The trip pawl, as it moves to the left (Fig. 4A) engages the teeth on the ratchet arm (Fig. 4B). Then, when the eccentric groove forces the trip lever to move in the opposite direction (Fig. 4C), the trip pawl straightens up and pushes on the ratchet arm. This moves the ratchet arm in the direction shown by the arrow, allowing the trigger to drop downward.

Positional Trip. Incidentally, this same changer also has a positional trip.

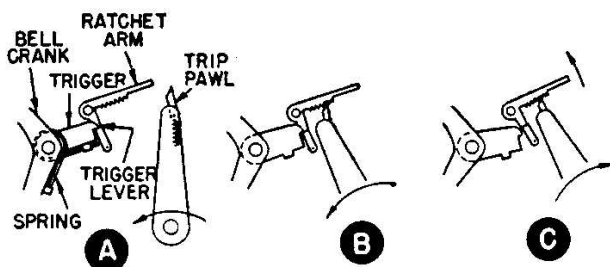


FIG. 4. Another eccentric trip.

That is, it is so arranged that should the eccentric trip fail to operate, the device will automatically trip anyway when the pickup arm reaches a fixed position from the spindle. The mechanism for this is shown in Fig. 5. An adjustable screw called a limit stop is fixed to the trip lever. If the trip lever moves far enough counter clockwise in Fig. 5, this stop will strike the lower end of a pivoted fork called a trip link. If this happens (it can happen only if the trip pawl has not yet moved the ratchet arm), the trip link will pivot clockwise, moving the ratchet arm and releasing the trigger.

Velocity Trip. Fig. 6 shows one of the velocity systems. There are many styles of these, but practically all of them depend upon some friction device that does not trip the mechanism until

the pickup arm travels inward at high speed, as it does in the eccentric groove.

In Fig. 6, the pickup arm is coupled through a link to a friction plate. Therefore, the friction plate is pushed clockwise in this figure. This motion is transferred to the trip arm through

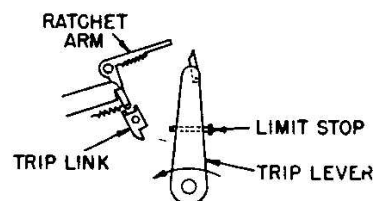


FIG. 5. A positional trip.

a friction pad that is between the friction plate and the trip arm. The amount of friction here is very little, but it is sufficient to move the trip arm clockwise. There is a projection called a striker on the spindle at the center of the turntable. This striker moves clockwise in this illustration. As the trip arm moves during the playing of the record, the end of the trip lever is brought to where the striker can hit it.

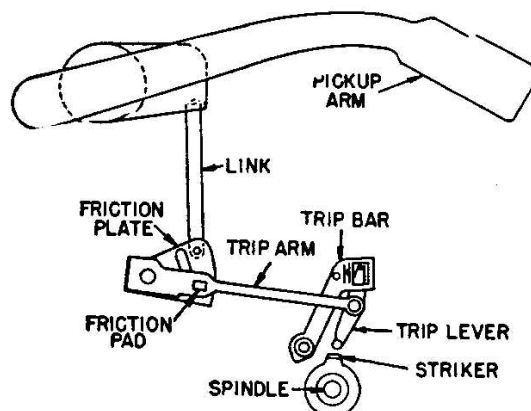


FIG. 6. A velocity trip.

This feed-in of the trip lever is very slow. As a result, just the very tip end of the lever is eventually hit by the striker on one of the revolutions of the spindle. When the striker hits the trip lever such a slight and glancing blow, the trip lever jumps back away from the striker. The amount of friction be-

tween the trip arm and friction plate is such that the trip lever can thus escape from the striker during the normal playing of the record.

However, when the eccentric groove is reached, the pickup arm moves in toward the spindle very rapidly. As a result, the friction plate moves the trip arm in rapidly, so the trip lever is moved well over in front of the striker during a single revolution of the spindle. As a result, the striker now hits the side of the trip lever a full blow. The trip lever cannot now escape, because the pressure is no longer applied to its end but is applied to its side. Therefore it pivots at its junction with the trip arm, forcing its other end to the left in the slot in the trip bar. The trip bar is then forced to move to the left and thus engages the mechanism.

To sum up what we have learned: The eccentric groove that is cut on all modern records is used to notify the automatic mechanism that the end of the record is reached. Through a trip mechanism that depends on the waving back and forth produced by the eccentric groove, or on the velocity of travel during the eccentric motion, or on the fact that the pickup arm is brought within a preset distance from the spindle, some tripping mechanism is actuated that allows the automatic mechanism to go into action. In every instance, a trip lever or mechanism attached to the pickup arm (light in weight so that it puts no real restriction on the pickup arm motion) transfers the eccentric motion through other levers to a mechanism that allows the turntable motor to operate the changer mechanism.

Of course, as you might expect, there are many variations on these basic devices. There are even some types in which a switch is closed by the tripping mechanism, and the actuating system is electrical. However, regardless of

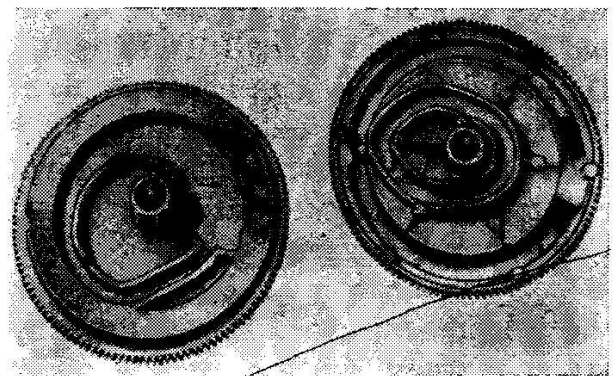
the system, all tripping mechanisms have the purpose of initiating the changer action. And they all have their troubles—they fail to trip, or trip too early, depending upon their adjustment, the tensions of their associated springs, etc. We will discuss some of these troubles later in this Lesson.

THE MAIN CAM

It is necessary that all the changer actions be synchronized with each other—the pickup arm must be removed at the proper time, just before the next record drops into position; and, once the record has dropped, the pickup must be brought back. To control these actions simultaneously, changer mechanisms are arranged so that the entire cycle is controlled by a single main cam or by a single drive mechanism that operates all the cams simultaneously.

Fig. 7 shows the top and bottom views of a typical main cam. The top view is shown at the left. Notice that there are a number of grooves, rims, and raised ledges on this wheel, all of which are used to control, individually, some particular portion of the changer operation.

To prevent the main cam wheel from rotating when power is not applied, usually some form of detent is used to latch the wheel in the out-of-cycle position. In the example shown in Fig.



Courtesy Motorola, Inc.

FIG. 7. A typical main cam wheel.

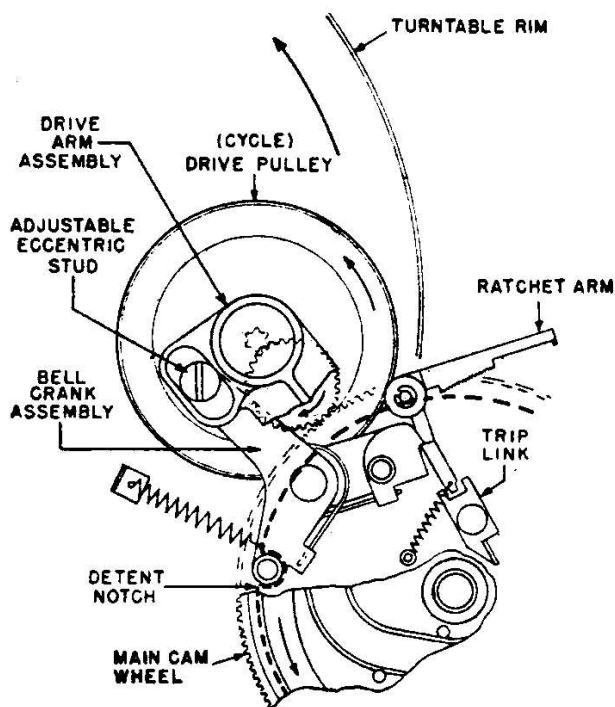


FIG. 8. One way of supplying power to the main cam wheel.

7, notice the detent notch at the left edge in the top view. A stud on the end of a lever fits into this notch until power is applied. This stud is withdrawn when power is applied so that the main cam can rotate and control the mechanism. At the end of the cycle, the stud is traveling on the rim, and falls into this detent notch just as at the end of the cycle to hold the main cam wheel motionless again.

There are almost as many ways of supplying power to the main cam wheel as there are record-changer systems. Fig. 8 shows the method used for the particular cam that we have shown in Fig. 7. First, if you will examine the bell crank assembly, you will find that the lower end has a stud that fits into the detent notch on the main cam wheel. The upper end of the bell crank assembly is fastened to a drive arm assembly. On this drive arm is a drive pulley that operates a small gear. This gear drives an idler gear that is meshed with the gear teeth on the main cam wheel.

When the ratchet arm moves away

so that the trigger can fall downward, the bell crank moves in accordance with this motion. As a result, the lower end of the bell crank is moved outward so that the stud moves out of the detent notch; at the same time, the drive pulley and the whole drive arm assembly are forced over by the movement of the upper end of the bell crank so that the drive pulley touches the turntable rim. Since the turntable is being driven by the motor, the drive pulley starts to rotate, driving the main cam wheel through the gear train.

When the changer has run through its entire cycle and the pickup arm is being put back on the record for playing, the main cam wheel rotates to a position where a raised section on the wheel engages the trigger and forces it upward. When the trigger reaches the proper position, the spring on the lower end of the ratchet arm pulls the shelf under the lip of the trigger, resetting the trigger for the start of the next cycle.

The trigger is connected to the bell crank by a very heavy spring. When the trigger is reset, this spring would force the bell crank to pull the drive mechanism out of contact with the turntable rim, except that at that instant the stud on the end of the bell crank is riding on the rim of the main cam wheel, which holds the bell crank so that the drive mechanism still operates. When the detent notch comes around, however, the stud on the bell crank falls into this notch; this allows the upper end of the bell crank to pull the drive pulley away from the turntable rim. The main cam wheel does not turn again until the end of the next record or until a reject button is depressed to release the trigger again.

Another system is shown in Fig. 9. The tripping mechanism is that shown in Fig. 3, but this time the drawing is

such that we are looking at the mechanism from the bottom.

When the trip pawl engages the ratchet lever, the left-hand end of the lever in Fig. 9 is forced downward, which raises the right-hand end. This frees the drive cam pawl and also takes a stud on the ratchet lever out of a

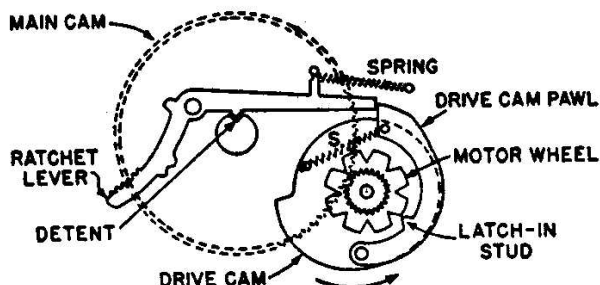


FIG. 9. The ratchet lever holds the drive-cam panel away from the motor wheel until the trip mechanism is actuated.

detent on the main cam, much as in the system we just described.

However, the drive mechanism is a little different here. The motor wheel is actually a form of gear having a number of slots cut in it. This turns all the time. The drive cam is a circular wheel mounted over the motor wheel. On the drive cam is a drive cam pawl, which has a latch in stud on it that will fit into the slots on the motor wheel when the drive cam pawl is released. Attached to the drive cam is a small gear that has teeth engaged with the main cam.

Therefore, when the ratchet lever releases the drive cam pawl, the spring S pulls the drive cam pawl over so that its latch-in stud engages the motor wheel. When this happens, the motor wheel revolves the drive cam, which in turn revolves the small gear and drives the main cam.

Meanwhile, the ratchet lever is held up from the position in which it engages the drive cam pawl, because a bump on the lever is riding on the rim of the main cam detent. When this bump reaches the notch of the detent, the ratchet lever spring pulls the lever

down into the notch. This brings the right-hand end of the ratchet lever down in front of the approaching drive cam pawl. As soon as the drive cam rotates sufficiently for the ratchet lever to engage the pawl, the pawl stud is pulled away from the motor wheel; this stops the driving of the mechanism.

Fig. 10 shows an electrical system for controlling the application of power to the main cam. In this system, there is a main drive wheel, practically the same size as the main cam, that is adjacent to the main cam. On the main cam there is the drive pawl shown in Fig. 10. This pawl cannot engage the teeth on the drive wheel until the armature of the relay R is moved away from the upper end of the drive pawl. When the tripping mechanism closes a switch, power is applied to the relay, which draws away the armature and allows the drive pawl to be pivoted so that it engages the teeth on the main drive wheel. The main cam is then driven by the main drive wheel through the pawl. At the end of the cycle, the armature, which is released by now, is in a position to engage the end of the

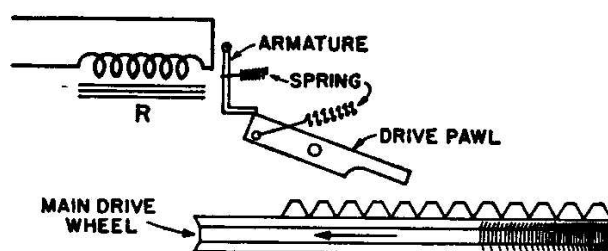


FIG. 10. A basic electrical system.

drive pawl and thus withdraw it from contact with the main drive wheel.

Fig. 11 shows another type rather similar to that shown in Fig. 10 except that the trip mechanism is mechanical. This trip mechanism holds the drive dog up from the drive wheel (Fig. 11A) until the trip is actuated. The trip then

moves out of the way, allowing the drive dog to drop down (Fig. 11B). The drive wheel has a series of bosses or raised projections on it; one of these catches the drive dog and thus forces the rotation of the main cam. At the end of the cycle, the drive dog is lifted

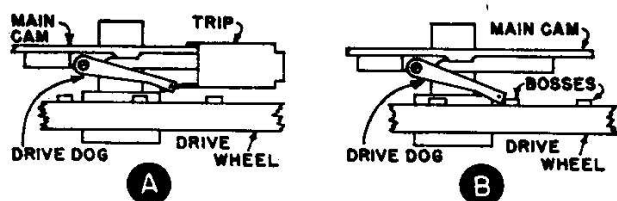


FIG. 11. Another drive-wheel system.

by the resetting of the trip mechanism, and the main cam is disengaged.

Now that we have arranged for the end of the record to signal the start of the automatic operation, and have learned how power can be applied to the automatic mechanism, let's go on and see how each individual action is carried out by the mechanism. Remember, we have to elevate the pickup arm and lower it, move it in and out, and drop the record to the playing surface. Although we shall break these down into individual actions, always remember that many of the processes may be combined so that a single master lever can perform several of these actions simultaneously. However, once you understand basically how each action is carried out, it will be rather easy for you to pick out and study that part of the operation of any record changer you may service.

PICKUP ARM ELEVATION

During each cycle, the pickup arm must be lifted and lowered. The arrangement for elevating the pickup arm is ordinarily separate from all the other functions. Fig. 12 shows two of the more popular systems.

In the system shown in 12A, the main cam has a cut-out space in it into

which the end of the lift lever fits while the pickup arm is on the record. The lever is shown in this position. When the end of the record is reached, the main cam rotates. The end of the lift lever then rides up on a raised ledge on the cam. This depresses the left end of the lever, which means that the right end of the lever goes up. This right end presses against a bearing plate and so moves a push rod upward through the center of the hollow shaft. The pickup arm is fastened at bearing A. Therefore, when the push rod moves upward, the needle end of the pickup arm is lifted. Other mechanisms then move the arm out of the way and drop the next record. When the arm is moved back into the playing position, the main cam is completing one revolution, bringing the notch on the cam ledge back into position over the left-hand end of the lift lever. This end of

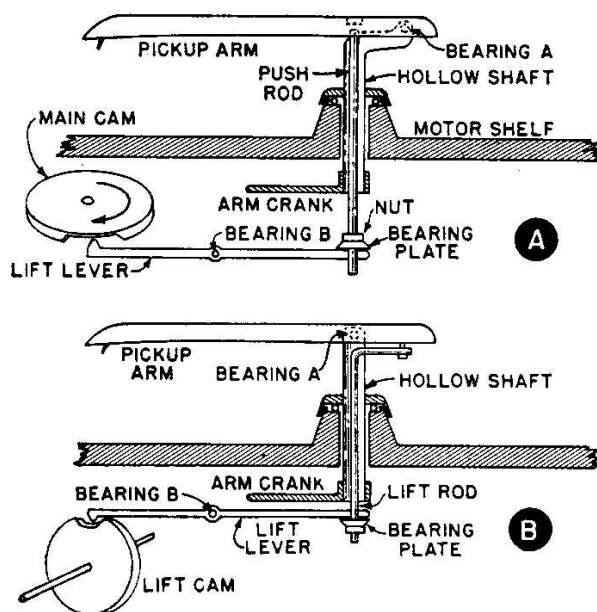


FIG. 12. Two basic elevator mechanisms.

the lever then rises, lowering the push rod and allowing the pickup arm to drop to the record. The main cam is then stopped so that it cannot rotate farther until the end of the record.

In the system shown in Fig. 12A, the push rod is threaded so that the bearing plate can be moved up or down.

This makes it possible to adjust the vertical movement of the push rod and consequently of the pickup arm. If the pickup cannot come down far enough to allow the needle to touch the record, then the bearing plate is too far down on the push rod. On the other hand, if the arm does not bring the needle up far enough to clear a stack of records on the turntable, the bearing plate is too high on the push rod. The latter condition is more common; it is corrected by lowering the bearing plate by screwing it downward on the push rod. In some systems, a nut follows the bearing plate and is used to lock it into position; in others, there are set screws in the hub of the bearing plate that are used to lock it.

The system shown in Fig. 12B is the same except that it is practically the inverse of that shown in A. Here, when the "lift cam" rotates, the left end of the lift lever is forced up, which pulls the lift rod down. Since the lift rod is bent at the top and attached behind bearing A, a downward movement of the lift rod pulls down on the rear end of the pickup arm and raises the needle end.

This mechanism can also be adjusted by moving the bearing plate up or down on the lift rod. Moving the bearing plate upward in this case provides a greater lift.

Fig. 13 shows two other basic systems of this kind. A cord is used in Fig. 13A to provide the lift. The cam in this case has an eccentric slot cut in it. The end of the lift lever moves in this slot. When the slot moves the lever toward the left, it pulls on the cord and so lifts the arm. Then, when the slot permits the lever to move to the right, the cord slackens and allows the pickup arm to drop. This system is usually adjusted at the point where the lift cord attaches to the lift lever. This end of the cord is normally at-

tached to a threaded rod that can be run in or out of a bracket, effectively adjusting the length of the cord.

The system shown in Fig. 13B is the simplest of all. Here, the cam is directly under the push rod. As the cam rotates, the push rod is forced directly upward by the shelf on the cam edge, lifting the pickup arm. Simple systems such as this are found in the less expensive changers. They work as long as the tolerances in parts are carefully controlled, but there is usually little or

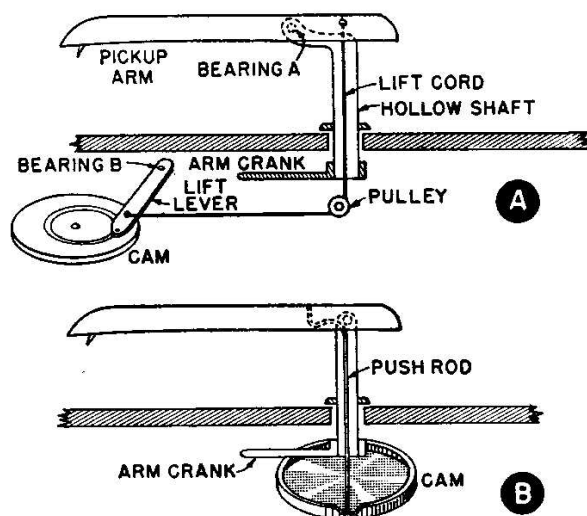


FIG. 13. Two more elevator mechanisms.

no means for adjustment. In the style shown here, the only manner of adjusting is to bend the push rod at the top. Any such bending operation is rather critical, since the rod is liable to break.

PICKUP ARM ROTATION

Now that you know various methods of elevating the pickup arm, let's see how the arm can be carried into the proper playing position and then removed at the end of the record.

In Figs. 12 and 13, you will notice a projection at the bottom of the hollow shaft labeled "arm crank." Moving the arm crank to the right or left will move the pickup arm similarly,

because they are connected by the hollow shaft. Therefore, all we need is to arrange for the arm crank to be controlled by the changer mechanism so that the pickup arm is moved in the desired manner.

To see the general way that this control is exerted, study Fig. 14. The arm crank is connected at bearing A to the pickup arm. The other end of the arm crank has a finger that is in an eccentric groove in the main cam. (To get a general idea of what some of these grooves look like, examine Fig. 7.) Let's suppose the eccentric groove has the shape shown in Fig. 14A. When the cam rotates around its bearing, marked C, it causes the finger on the arm crank to move so that it follows the groove. In Fig. 14A, the changer is in cycle and the finger of the arm crank is farthest from bearing C, which is at the center of the turntable. Therefore, the pickup arm is as far as it can be from the center bearing and is off the record completely.

Further rotation of the cam brings the groove to the position shown in Fig. 14B. The shape of the groove is such that the finger on the arm crank is now brought closer to the bearing C, bringing the pickup arm over the edge of the record. The elevator mechanism now allows the pickup arm to drop on the edge of the record just as the eccentric groove moves to the position where the finger enters the wide spacing of the groove. The finger is now released, because the cam ceases to rotate. The pickup needle now follows the record grooves, and except for moving the pickup arm, the trip, and the arm crank, the pickup is entirely divorced from the player mechanism.

As the needle is drawn toward the center of the record by the record groove, the arm crank moves through the free space. This space on our imaginary assembly is wider than the

rest of the eccentric groove so that there is no interference with the movement of the arm crank.

At the end of the record, the trip mechanism goes into operation and starts rotation of the cam. The position of the arm crank just before this moment is shown in Fig. 14C. As the cam rotates farther, the finger on the arm crank enters the groove. When the elevator has lifted the arm from the record, continued rotation of the cam toward the position shown in Fig. 14A rapidly moves the pickup arm out of the way so that the next record can be dropped.

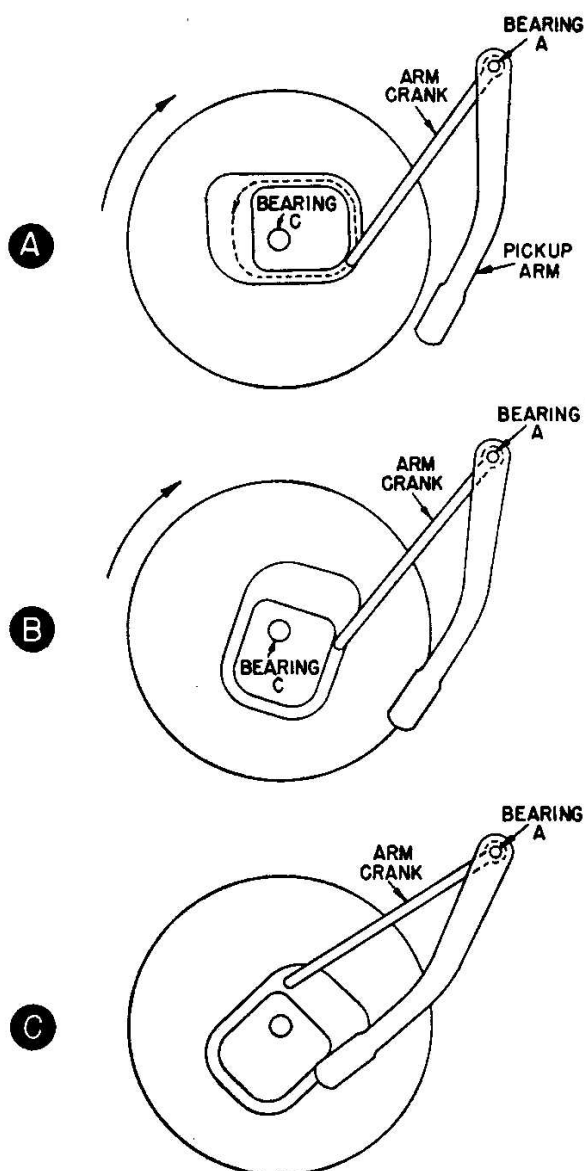


FIG. 14. A basic pickup arm left-to-right motion control.

The system shown in Fig. 14 is basically that used in all changers. However, the actual mechanism is considerably more involved than we have shown, because we must arrange for the pickup arm to be brought to the proper position for either 10-inch or 12-inch records.

If there were only one record size to be played, we could easily adjust the position at which the arm lands (the only critical factor) by adjusting the angle of the arm crank with respect to the pickup arm. However, we do have two record sizes. Let's look at some of the basic systems used to make it possible to shift from one to the other.

10-12 LANDING SHIFT

Fig. 15 shows one way of adjusting the position at which the pickup arm will land. An additional T-shaped crank is used between the arm crank and the groove in the cam. This T crank can be moved to either of two positions by rotating the control cam attached to it.

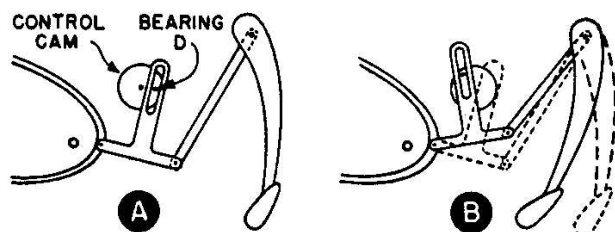


FIG. 15. A T-crank is used here to provide the landing adjustment for either 10- or 12-inch records.

In Fig. 15A, the T crank is in one of its two possible positions. As the cam rotates, the groove moves the finger on the end of the T crank, which transfers this motion directly to the arm crank and thus to the pickup arm. The T crank is able to follow the eccentric groove because a slot on the

crank permits it to move in all directions with respect to its bearing D.

To change the landing position from the 12-inch to the 10-inch position, the control cam in Fig. 15A is rotated 180°. This moves bearing D from one side of the control cam to the other, as shown in Fig. 15B. The T crank must now move along this new position. In Fig. 15B, the original positions of the T crank, arm crank, and pickup are shown in dotted lines. As you can see, the pickup arm now has a new position although the finger on the T crank is still in the same place on the eccentric groove. This means that the pickup arm will land in a different place when it is dropped by the changer mechanism. In this particular case, it will land an inch nearer the center of the turn-table, in the proper place for a 10-inch record.

A system of this sort usually has only one adjustment: the fastening between the arm crank and the pickup arm can be adjusted to make the pickup land properly on either a 10-inch or a 12-inch record. The pickup should then also land properly on a record of the other size when the control cam is turned to the other position.

Fig. 16 shows another basic system. Here, the cam has a raised ledge W that is eccentric with respect to the cam bearing C. The arm lever, which pivots about bearing E, is held against the side of this ledge by the spring S. The arm lever is therefore swung in and out by the eccentric ledge as the cam rotates.

Under the conditions shown in Fig. 16, the record is being played and the cam is motionless. This figure is drawn so that we are looking down through the top of the motor mounting board. The pickup (shown dotted here) is connected to the pickup arm crank at the bearing A, as in the systems we

have studied up to now. When in the position shown, the arm crank is not restricted at all, so the pickup arm is free to follow the record grooves.

The end of the arm crank has a

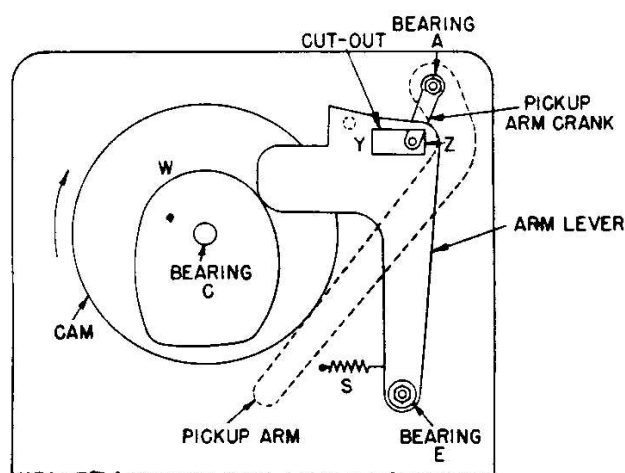


FIG. 16. Compare the operation here with that in Fig. 17.

finger that protrudes through the cut-out in the arm lever. As the pickup arm nears the end of the record, the mechanism is tripped, so the cam starts to turn. The pickup arm is elevated from the record by operation of the elevating mechanism, then the rotation of the ledge W begins to move the arm lever to the right. Soon end Y of the cut-out bears against the finger of the arm crank, thus forcing the arm crank to move to the right also. In turn, this swivels the pickup arm out of the way in the same direction.

When the next record has dropped, and the arm lever begins to return toward the position shown here, end Z of the cut-out presses against the arm crank finger and thus brings the pickup arm back in toward the edge of the record. At the proper point in the cycle, the elevator mechanism lets the pickup arm down on the record edge.

The operation just described is the one that occurs when a 10-inch record is played. Fig. 17 shows what happens when the mechanism is set to handle 12-inch records. The mechanism

used to control the size setting of the changer has either an arm or a pin that can be dropped down in front of a finger on the arm lever. When this pin is up or out of the way, as it is when the size control is set for 10-inch records, the arm lever bears directly on the ledge W at all times. However, if the control is set for 12-inch records, the pin (labeled stop H in Fig. 17) is dropped into place while the arm lever has the pickup arm at its extreme right-hand position. Then, as rotation of the eccentric ledge W brings the arm lever to the left, the lever strikes stop H; it can then travel no farther to the left. This position is the proper one for the 12-inch record size while the pickup arm crank finger is against side Z of the cut-out.

Now let's see what the cycle of operation of this mechanism is when it is set for 12-inch records. During the playing of the record the pickup arm crank finger moves through the

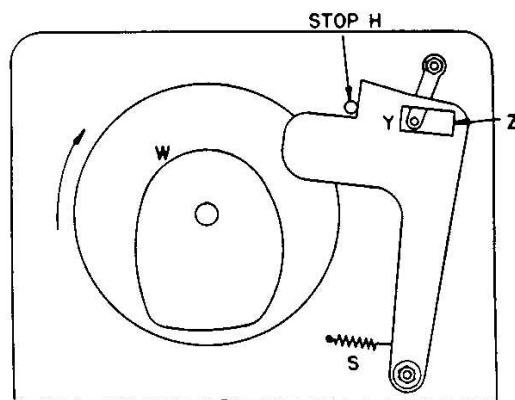


FIG. 17. Compare this 12-inch landing arrangement with the 10-inch one in Fig. 16.

cut-out opening to approach side Y. When the mechanism is tripped, the pickup arm is elevated. However, the arm lever cannot move until ledge W comes over and bears against it. Then, however, it is carried to the right to the same extreme position as before. Then, when the next record drops, the ledge W allows the arm lever to return as far



Courtesy Farnsworth Tele. and Radio Corp.

FIG. 18. A bottom view of a changer using the system described in Figs. 16 and 17.

as stop H. The arm is held here by the stop while the cam continues to rotate, and the pickup arm is allowed to be lowered to the record surface.

At either setting of the mechanism, then, the ledge W always moves the arm lever sufficiently to remove the pickup arm from the turntable vicinity so that the next record can be placed in position. On the return of the pickup arm, the arm lever either rides on ledge W for the 10-inch landing position, or is stopped by stop H for the 12-inch landing position. Once the pickup arm has been lowered to the record, the arm crank is entirely free of the changer mechanism and progresses through the cut-out space.

Fig. 18 shows a picture of a changer that uses this operation. Notice that much of the mechanism we have described is hidden by levers and support plates. Notice, also, that this is a photograph from the bottom, so it is the reverse of our drawing.

There are numerous other systems for bringing the pickup arm in to the record edge and removing it so that the

next record can be put into place. In general, all systems use eccentric grooves, eccentric ledges, or eccentric screw mechanisms to make the pickup arm move through the proper motions. Some systems use a double groove on the cam, one groove for 10-inch and one for 12-inch records, and have arrangements whereby the arm crank finger can be switched from one groove to the other. Basically, however, all of them go through the actions we have just demonstrated.

RECORD-DROPPING SYSTEMS

So far, we have learned how the pickup arm is moved in and out and how it is raised and lowered. Next, let's see how records are fed one at a time from the storage system into the playing position. In general (except for a few complex types that play both sides of records), all changers made today drop records from storage above the turntable. The differences between them are in the means of separating the bottom record from the group and of supporting the stack.

There is probably more difference between changers in this particular item than in any other. Basically, there are two methods of separating the bottom record from a stack so that it can be put into playing position. In one system, support shelves originally hold up all the records. As the changer goes into operation, a set of knives is inserted in the record stack between the bottom record and those next above it. Then the supports are withdrawn, allowing the bottom record to drop onto the turntable. The knives then support the group.

Once the bottom record has been dropped into playing position, the support shelves are returned and the knives withdrawn, allowing the record stack to drop down onto the shelves.

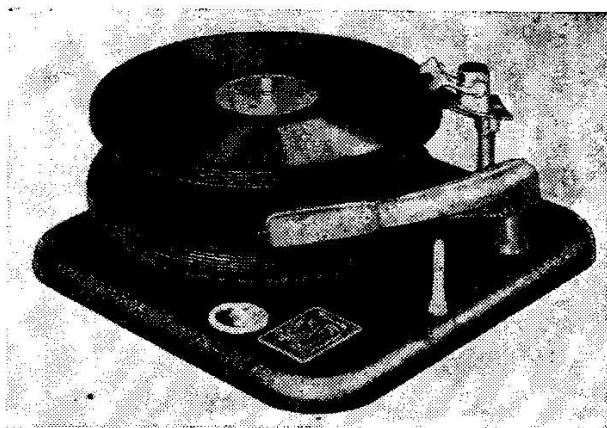
The system is now ready for the knives to separate the bottom record of this stack on the next playing sequence.

In the other system, the bottom record is pushed off a supporting ledge, which then catches the remaining records.

Let's now turn to several typical changers and see just how they work. We can divide them into single-post, two-post, and three-post types.

SINGLE-POST CHANGERS

Figs. 19 and 20 show pictures of two basic single-post record changers. On these changers the records are sup-



Courtesy Motorola, Inc.

FIG. 19. A single-post, straight-spindle record changer.

ported by an offset ledge on the center spindle and by a single side post or platform. In the style shown in Fig. 19, the spindle is straight; the one shown in Fig. 20 has a "bent" spindle.

Straight-Spindle Types. Fig. 21 shows more details of a single-post straight-spindle changer. A section of the spindle at the center of the turntable is cut out to form a shelf. At the rear of this shelf is a guide trigger that makes the records move in the direction of the support head as they feed down the spindle. The records are thus supported at their center hole by the shelf on the spindle and at one outside edge by the support head.



Courtesy Webster-Chicago

FIG. 20. A single-post, bent-spindle record changer.

Two systems of making the bottom record drop down the spindle onto the turntable are in use. In one, operation of the changer mechanism makes a trigger protrude from the support head when the pickup arm has been moved out of the way. This trigger pushes the bottom record to the left so that its center hole lines up with the spindle and its edge is off the support head. Unsupported, the record spirals down the spindle to the turntable. The trigger withdraws into the support head, and the next record in the stack drops down onto the shelf and onto the lip of the support head at the same time.

When the record that dropped finishes playing, the cycle is repeated and the next record is dropped.

In this particular system, the adjustment for 10- or 12-inch records is made by rotating the support head. By com-

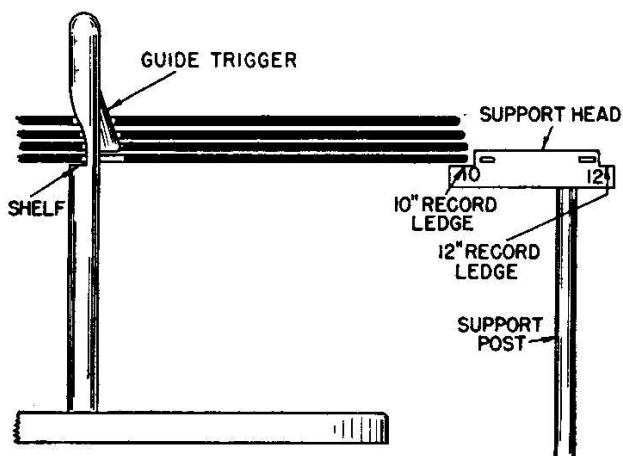
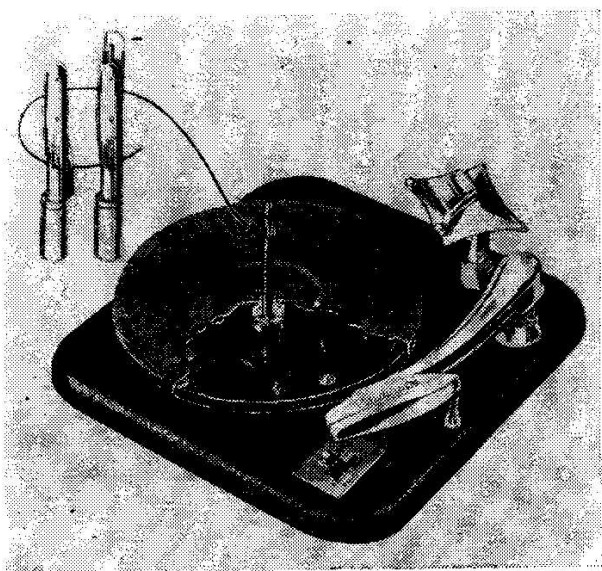


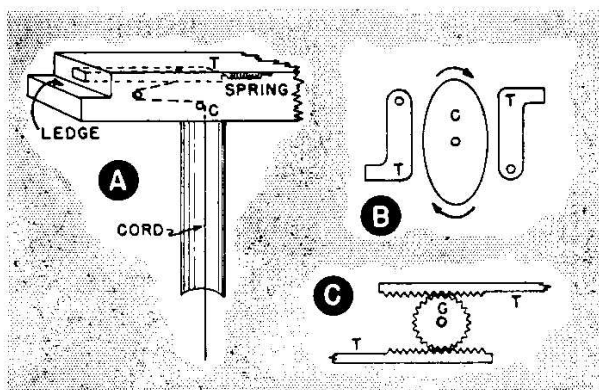
FIG. 21. Details of a straight-spindle changer.



Courtesy Motorola Corp.

This shows how the guide trigger retracts as records are lifted up the spindle to remove them from the changer. The trigger drops into playing position, however, as records feed down the spindle.

paring the distances from the support post to each of the record ledges in Fig. 21, you will see that the ledge marked 10 is spaced farther from the post than the ledge marked 12. Therefore, the 10-inch ledge extends closer to the spindle, and is just the right distance away for 10-inch records. When the support head is rotated 180°,



Three of the many methods of actuating a trigger to push a record off the ledge of a support head. At A, the cable C is pulled by an arm traveling in a groove on the main cam, and this motion forces the trigger T to protrude. At B, the cam C is rotated by a shaft that runs down the support post; this forces the triggers T to protrude because of the eccentric cut of the cam. At C, the gear G is rotated to force the triggers T to protrude, then the direction of gear rotation is reversed to pull them back in. The types at A and B are pulled back in by springs.

the 12-inch ledge is the right distance from the spindle to accommodate 12-inch records.

Some changers of this sort have a link mechanism down the support post column so arranged that rotating the support post head also adjusts the mechanism underneath to make the pickup arm land at the proper place for a 10-inch or 12-inch record. In others, it is necessary to set the support head and then throw a switch to adjust the landing point of the arm.

When the records have all been played, the support post is turned to a neutral position in which the shelves are out of the way. (Incidentally, this

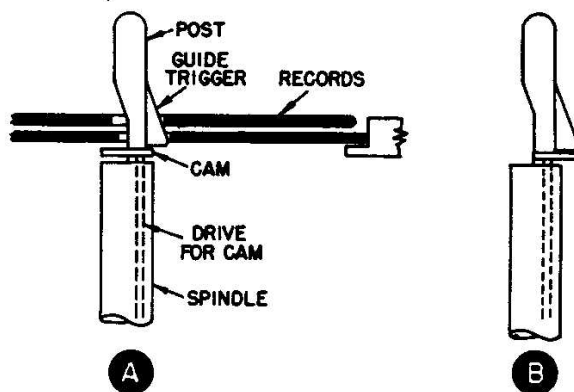


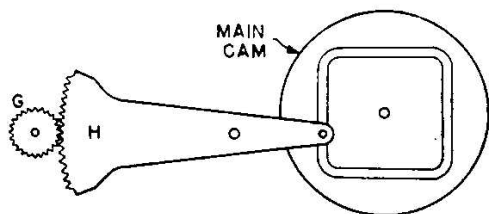
FIG. 22. Details of a cam system of aligning records with the spindle.

is the position to which the support post is turned when the record changer is played manually.) Then, the stack of records is lifted up the spindle. On most models, the guide trigger on the back of the spindle slides into a slot in the spindle and thus out of the way as the records are lifted upwards.

Another style of single-post straight-spindle changer uses an eccentric cam to take the bottom record off the stack. Details of its construction are shown in Fig. 22. The spindle is hollow and has within it a drive shaft to which is fastened the cam. This drive shaft is offset toward the rear of the spindle

so that the cam will move in an eccentric fashion with respect to the spindle.

When the cam is in the position shown in Fig. 22A, it is lined up with the bottom portion of the spindle. It then acts as the top of the spindle to form a shelf upon which the records rest. As in the system just described,



The eccentric cam drive in Fig. 22 is attached to the gear G. This is driven here by the drive H, that in turn operates from a groove in the main cam. The drive works in one direction, then runs back to return the cam to its initial position.

the guide trigger directs the records, as they move down the post, onto the shelf furnished by the cam and onto the lip of a support head.

Let's suppose records have been loaded onto the mechanism as shown in Fig. 22A. When the changer first starts to operate, and the pickup arm is out of the way, the cam above the spindle is rotated by its drive shaft to the position shown in Fig. 22B. This brings it directly under the center hole of the bottom record, which then drops over the cam. The cam is not quite as thick as a standard record, so no more than one record can get onto it. The cam then rotates back to the position shown in Fig. 22A, dragging the bottom record with it and off the lip of the support head. When the cam is lined up with the spindle again (Fig. 22A), the record drops down the spindle to the turntable, and the next record is supported by the cam.

The storage mechanism of this type of changer, like that of the one previously described, is adjusted for record size by rotating the support platform.

The Bent-Spindle Changer. Fig. 23 shows a variation on the single-post changer. The spindle is like the others in that it has a shelf and usually a guide trigger. However, it has a bend in it that permits a somewhat different construction and action. The records feed down the spindle and over the trigger so that the shelf on the spindle supports them. The outer edges of the records are supported by a record head, which has a shallow notch into which the bottom record fits. The actuating means for getting the records to feed down the spindle is in the record head itself—the head and its support post move toward the spindle. When the head moves forward, the bottom record is pushed forward also by the back edge of the notch in the head; the rest of the records, however, slide back along the platform in the head just above the notch. When the center hole of the bottom record lines up

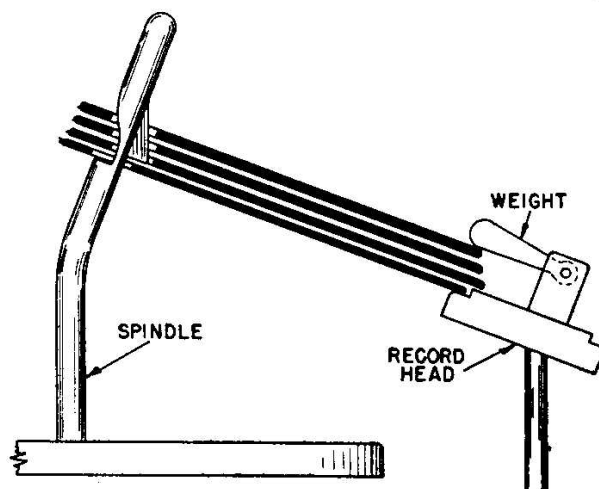


FIG. 23. A bent-spindle type.

with the spindle, the record feeds down the spindle. In going around the bend of the spindle the record is pulled away from the record head so that it falls free onto the turntable.

The next record then drops down on the shelf of the spindle. At the end of the playing cycle, the record head moves back away from the spindle, allowing the bottom record to drop into the notch in the head. It then

moves forward again, pushing the next record off the spindle shelf.

In the type shown in Fig. 23, the record head is revolved to play 12-inch records. Sometimes a switch or button must be actuated to cause the pickup arm to drop in the right position with this system.

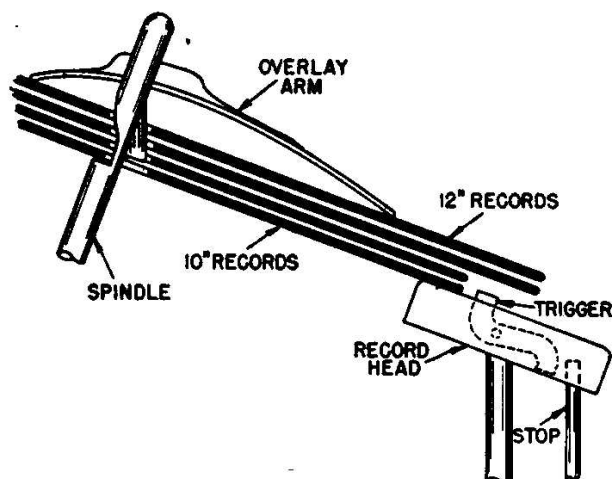


FIG.24. This bent-spindle type is an inter-mixing changer.

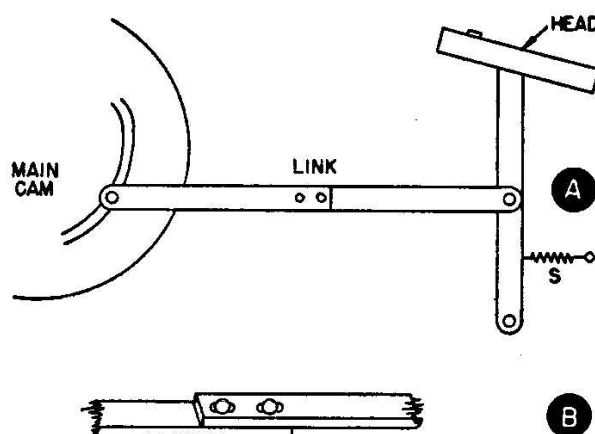
To prevent the records from tilting, there is a hinged weight on the record shelf that is dropped on top of the record stack. (Most single-post changers use such a weight.) This weight holds the records steady while the shelf moves back and forth underneath the stack.

To load this changer, the weight is moved out of position, the stack of records is fed down over the top portion of the spindle, and the weight is then replaced. To remove the records, the weight, which protrudes somewhat, must be rotated out of position, or the entire record shelf must be turned 90° to clear the record stack as it is lifted off the spindle. In many of the bent-spindle types, the spindle can be lifted out of its socket so that the records can be removed without having to feed them up the spindle.

Some of the bent-spindle changers can play records that are mixed in size. Fig. 24 shows one system. The

record head contains a trigger. When the records are placed on the storage portion of the spindle, 10-inch records will rest on the front edge of the head, ahead of the trigger, and 12-inch records will extend over the trigger. Let's suppose we have the stack as shown in Fig. 24. When the first record, a 10-inch one, is to be played, the record head moves forward; the trigger, which is a square protrusion on the head, strikes the edge of the record and forces it off the shelf on the spindle.

When this record drops, the next 10-inch record drops down in front of the trigger. It, too, is pushed off by the trigger on the next operation of the changer. The next record, however, is a 12-inch one; therefore, it drops on top of the trigger instead of in front of it. The trigger is pivoted (see Fig. 24),



The link pulls the head forward against the pull of spring S. At B is shown the method of adjusting the length of the link, which adjusts the limit of forward motion of the head. Another lever (not shown) may be attached to the head support post to shift the link into the proper groove on the main cam for either the 10-inch or the 12-inch record sizes.

and the weight of the record on top of it pushes it down flush with the top of the record head. As shown by the dotted lines, this raises the rear end of the trigger so that it is above a stop that up to now has prevented the record head from moving more than a certain dis-



Courtesy Garrard Sales Corp.

FIG. 25. An inter-mixing bent-spindle changer.

tance from the spindle. When the rear end of the trigger is able to clear this stop, the record head is able to move considerably farther from the spindle—so far, in fact, that the trigger is brought out beyond the edge of the 12-inch record. The weight of the rear end of the trigger restores it to its original position once it gets out from under the record, so, when the record head moves forward again, the trigger is behind the edge of the 12-inch record and pushes the record off the spindle shelf.

This mechanism also automatically sets the landing position of the pickup arm for 10-inch or 12-inch records. The motion of the record head sets stops that control the pickup arm crank, with the result that the landing position of the pickup arm depends on

whether the record head has moved back for a 10-inch or for a 12-inch record.

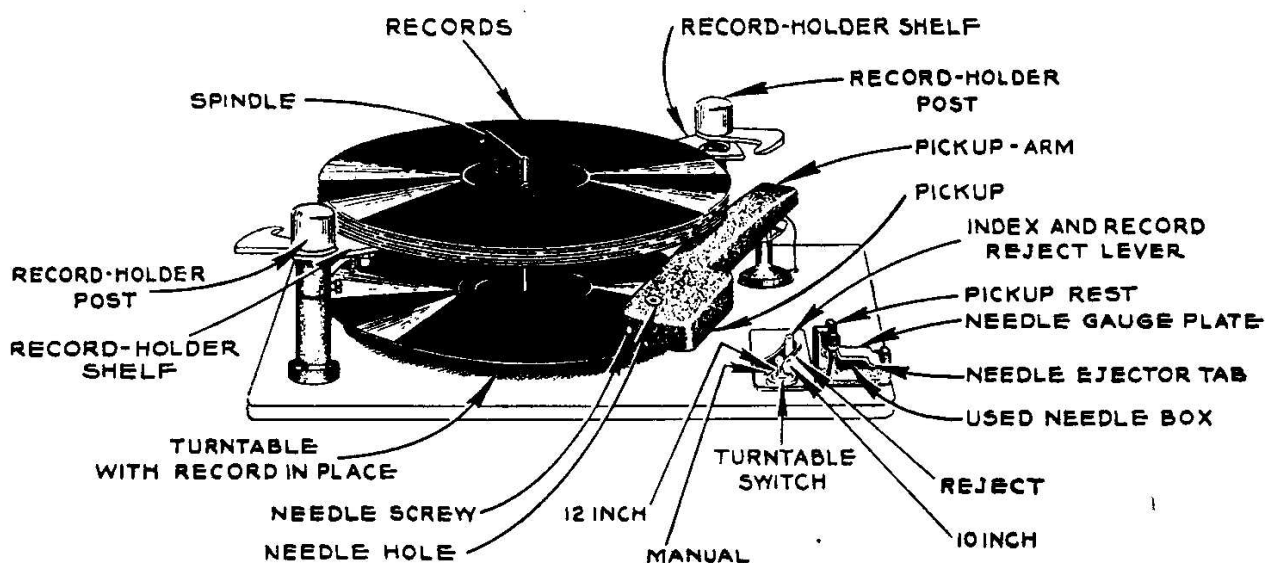
Fig. 25 shows a picture of a unit of this type. Notice the overlay arm that lies over the top of the records and straddles the spindle. This arm is necessary in this system to keep the records level while the record head moves back and forth and also to provide the force to keep the records moving down the spindle. It serves a purpose somewhat similar to the weight in the system shown in Fig. 23. However, because of the wider motion of the record head here, the overlay arm must be accurately positioned.

TWO-POST CHANGERS

Fig. 26 shows one of the two-post record changers. In this style, the center spindle is used only for guiding the record down to the turntable—it has no shelf on it.

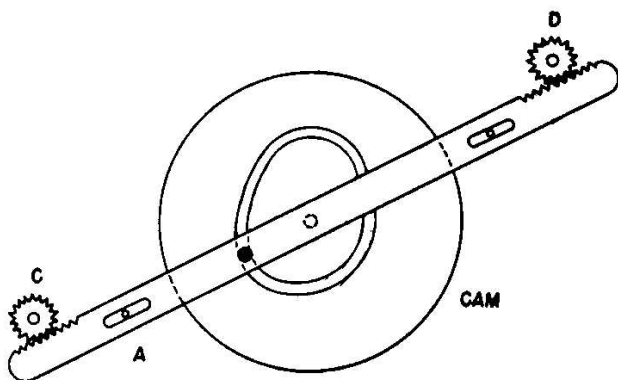
The record is supported at two points by record-holder shelves that are attached to the record-holder posts.

When a record is to be dropped, the pickup is elevated and moved out of the way. Then the record-holder posts begin to rotate. Each of these posts carries a “knife” just above its rec-



Courtesy RCA

FIG. 26. A typical 2-post changer, the RCA U-128.



The support posts may be rotated by means of a belt or gear system from the main cam. Here is a simple gear type; the arm A is moved from side to side by the eccentric groove in the main cam. It rotates gears C and D that are at the base of the support posts. Hence, the posts and accompanying knives are rotated about 180° , then are returned to their resting positions.

ord-holder shelf. This knife is a sharp-edged shelf that is spaced approximately the thickness of the average record above the record-holder shelf. Therefore, as each knife comes around and contacts the record stacks, the pointed tip of the knife is in just about the right position to go in between the bottom record of the stack and the one next above it. The mechanism rotating the knife is usually either spring loaded or allowed to have considerable play so that the knives can adjust themselves and slip in between the bottom record and the stack.

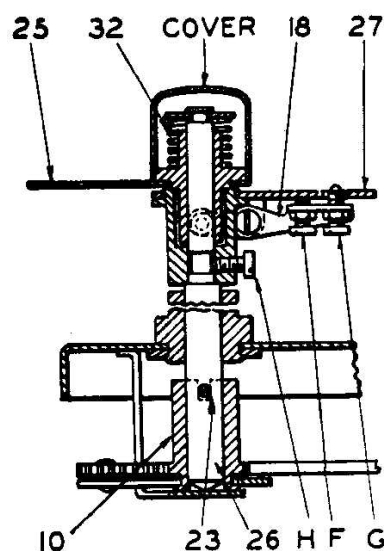
As the knife penetrates the record stack, continued rotation of the record-holder post will place the knife under all the records except the bottom one, and the record-holder shelf will be rotated completely out of the way. When this happens, the bottom record no longer has anything to support it, and the remainder of the record stack is supported by the knives on the two posts. Therefore, the bottom record drops onto the turntable. Before the pickup arm is placed in the playing position, the record holder posts rotate back to their normal positions. This withdraws the knives and drops the stack of records onto the

record holder shelves, thus completing the changing cycle. The thickness of 10-inch records is somewhat different from that of 12-inch records. Although the knife is so loose that it will usually find the proper spacings and go in between the records, it is always possible for the knife to strike the edge of a record and cut into the record rather than separate it from the stack.

On some changers, the spacing is adjustable. Fig. 27 shows the details of one such system. The small screw marked G protrudes through the record-holder shelf. When 10-inch records are on the shelf, they do not extend over the shelf far enough to reach this screw. However, 12-inch records will lie on the screw and depress it.

When 10-inch records are on the shelf, the knife spacing above the shelf is that of the average 10-inch record. When the thicker 12-inch records are on the shelf, screw G is depressed, and a lever arm connected to it raises the knife slightly so that the spacing between the knife and the record-holder shelf increases enough to clear the records.

This form of storage mechanism will usually permit the intermixing of 10-



Courtesy RCA

FIG. 27. How the knife spacing may be adjusted.

and 12-inch records. Some of them require setting for the record size, in addition to setting the index lever to the proper position to control the pickup arm landing position. Others, of which the one we are discussing is an example, determine the record sizes automatically.

The mechanism used to do so in this changer is shown in Fig. 28. The lever 17 stands beside the turntable. Ten-inch records drop from the record support shelves to the turntable without striking lever 17. When this happens, the pickup arm automatically comes in for the 10-inch position.

However, a 12-inch record, because of its greater diameter, strikes lever 17 as it falls. This pushes the lever to the right in this drawing, moving its end out of the way of the pin marked V. This allows the pickup arm crank to move to the proper position for a 12-inch record.

Another form of two-post changer is shown in Fig. 29. In this, the spindle has a crook or hump in it. There are two heads on which the records are supported. When the device is actuated, the spindle is rotated by the main cam through a gear system.

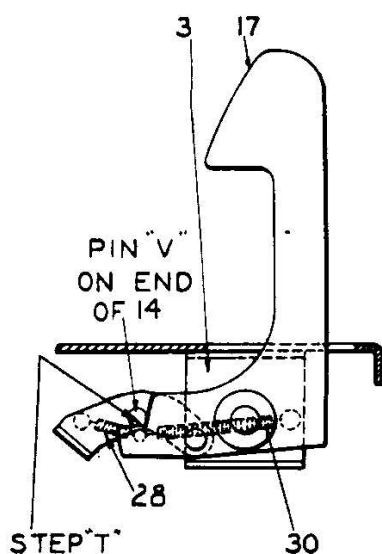


FIG. 28. The lever 17 controls the mechanism that sets the pickup landing according to the record size.

Courtesy RCA

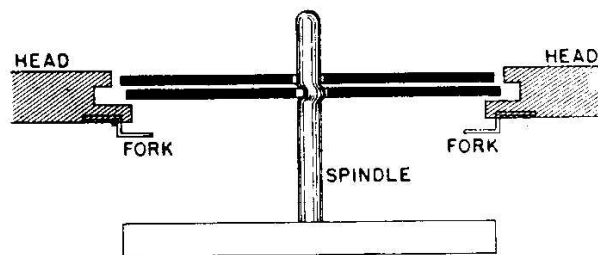


FIG. 29. Another two-post changer.

In its initial position, the hump is at a point halfway between the two support heads. As it rotates, however, the hump approaches the left-hand head, thus forcing the bottom record into the slot in the left-hand head. This pulls the other edge of the record from the support ledge of the right-hand head and allows it to drop on the right-hand fork. (This fork is a movable support bar.) Then, as the spindle continues its rotation, the hump pushes the record to the right, into the slot provided by the fork on the right-hand head. This pulls the record from the supporting shelf on the left-hand head, allowing this edge of the record to drop similarly on the left-hand fork. The spindle comes to a stop in its neutral position, and the bottom record is now supported at both edges by the forks just below the two heads. The next records are down on the support shelves of the heads. Just before the record is to be played, the two forks are withdrawn by a linkage down the support post, allowing the bottom record to drop down the spindle.

Thus, the operating principle of this changer is that rotation of the spindle moves the bottom record from its support posts onto two forks, which are then withdrawn to allow the record to drop onto the turntable.

THREE-POST CHANGERS

The three-post changers are usually of the knife-blade type like the one shown in Fig. 26, except that they have three posts 120° apart instead of

two posts 180° apart. The same cycle of operation is used—three knives go in between the bottom record and the remainder of the stack, then the support shelves are withdrawn to allow the bottom record to drop.

It is possible to make either the two or three-post changers intermixing types by causing the record to strike a lever as it drops, or by using a trigger mechanism on the support shelves that is depressed by 12-inch records.

Servicing Record Changers

In the preceding section, we have analyzed the operations of changer mechanisms separately because, in general, you will find that only one thing is wrong when they are out of adjustment. That is, the trip mechanism may fail to operate or operate too



Courtesy Motorola, Inc.

A bottom photograph of a typical record changer. This is the type of photo given in the manufacturer's manuals.

soon, the pickup arm may not be picked up high enough or may not be let down low enough, the records may not be dropped, or more than one may drop, and so forth. Of course, it is always possible for the mechanism to jam completely, stopping all operation. Such jamming can be the result of a failure of some part or the result of

mishandling of the changer. Most particularly, jamming can occur when someone moves the pickup arm while it is "in cycle"—that is, while the mechanism is trying to manipulate the pickup arm itself. (Moving the pickup arm while it is in cycle may also throw the changer out of adjustment.) Generally, however, the trouble is in only one portion of the change cycle. Therefore, when you are called on to service a record changer, first determine exactly what it fails to do or does incorrectly. You can then tell what adjustments need to be made to put it back in proper operating condition.

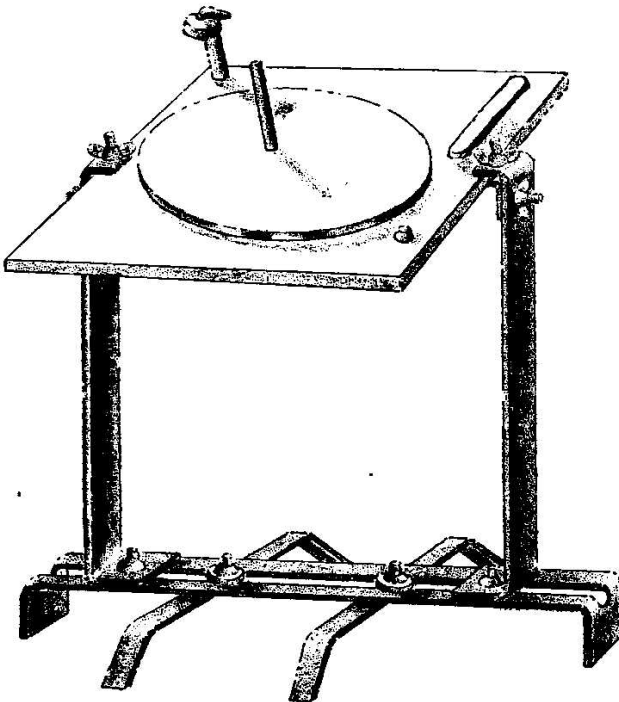
Even though you know just how a changer should perform a certain task, you may still have to spend a considerable period of time watching it go through its cycle again and again before you can see exactly which lever, gear, crank, or arm is incorrectly performing its duty. To save time, you should have all the information you can get on any particular record changer that you have for service. Fortunately, because of the complexity of changers, the manufacturers publish rather complete service manuals. These may be obtained directly from the manufacturers, like any other service information.

In addition, you can obtain much valuable service information in the Service Manuals of Rider and Howard

W. Sams. These Automatic Record Changer Service Manuals cover many different models. They are available from radio supply houses and local wholesalers.

However, if you have to service a changer on which you do not have service information, and you cannot get this information in time to complete the job, all you can do is run the changer through its operation several times and watch it carefully. By locating the apparatus that controls the faulty action, you will usually be led right to the proper adjustment.

Before you can seriously consider the servicing of automatic record changers, you must have some means available for supporting the changer on your workbench so that you can see underneath it as well as above it.



Courtesy General Cement Co.

FIG. 30. A commercial adjustable cradle for holding record changers. This style can be tilted for servicing without the changer's being removed from the cradle.

This support must maintain the changer in a level, normal playing position. This is important. In fact, many service complaints are brought about by the changer's not being level.

For example, the pickup arm is adjusted to land in the blank space at the outer edge of a record. Then, if the changer is level, a slight spring pressure or gravity feed will cause the needle to move over toward the spindle sufficiently to engage the first playing groove. If the changer is not level, the needle may not move into the playing groove, or may even jump the other

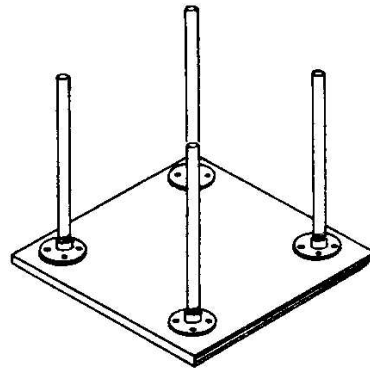


FIG. 31. A home-made jig. The leg spacing must be adjusted for different changers.

way—completely off the record. Similarly, in cases where the spring tensions are critical, you cannot have the changer up on edge without putting excess tension on some springs or releasing others so that the changer cannot perform satisfactorily.

There are several support jigs for record changers that may be purchased from the radio supply houses. A typical one is shown in Fig. 30. If you prefer, you can make a jig like the one shown in Fig. 31. Of course, the spacing between the posts will be proper only for certain types of changers, so a home-made gadget of this kind is not quite as flexible as are some of the adjustable commercial jigs. In any case, the jig must fit the changer, must support it securely, and must hold it level. To be useful, the jig must hold the changer above the workbench high enough for you to see and adjust the changer mechanism from underneath. You don't have to put your head under the changer to watch its

operation—you can always use a mirror to let you see underneath—but you will usually have to get under it yourself when you make adjustments.

When you are servicing a record changer, it isn't always desirable to have electric power applied. The changer may run through its operation too fast for you to watch everything sufficiently, or there may be some jamming condition that could actually damage parts if power is applied. For this reason, it is frequently necessary to disconnect the motor from the power line and rotate the turntable by hand to drive the changer mechanism slowly through its cycle of operation.

Sometimes you will find that support straps, mounting boards, or other objects obscure the view of the parts you want to watch. In such a case, removing the turntable may let you see the mechanism underneath. However, this won't always prove helpful—in some instances the motor board is solid, and only the spindle comes through the board. If so, removing the turntable does not permit you to see underneath at all.

Now let's describe a few basic troubles and learn their remedies before going on to examples of manufacturers' service data.

NON-STANDARD RECORDS

A great deal of the trouble experienced with record changers is caused by the fact that the records involved are warped or are not standard in some way.

The standard 10- and 12-inch records made by the reputable manufacturers are all held reasonably close in their sizes. They are of the proper thickness and diameter, and in general the edges of the records are smoothly rounded. However, it is always possible for even a standard record to be

outside tolerance in some way, and many of the records made by smaller companies are not standard at all. Here are a few of the troubles caused by non-standard records.

No Eccentric. You will find that many of the older recordings either do not have an eccentric groove at the center of the record or have one so shallow that it cannot trip some of the changer mechanisms. This is particularly true of some of the earlier classical recordings. Unfortunately, these classics are frequently the very records that appeal to owners of record changers. They may not realize that the eccentric groove is necessary for the trip, so you may very well get a call to repair a changer because it does not trip, when actually the trouble is this lack of an eccentric groove. Be sure to find out from the customer on such calls whether the mechanism fails to trip only on certain records—he may have noticed this characteristic, which will lead you at once to the trouble.

There are a few records, mostly foreign ones, that have the eccentric groove but carry the recording groove too close to the center spindle. This is perfectly all right as long as the trip mechanism operates from the eccentric groove. However, if used in a changer having a positional trip (in which the trip is actuated as soon as the pickup arm is brought within a preset distance from the spindle), these records may tend to trip too soon. If you find that the changer has a positional trip, check the manufacturer's instructions to learn the distance from the spindle the device should be set. If it trips at the proper distance, the record is at fault.

Thickness Variations. Records that are too thick or too thin can cause trouble in the mechanism designed to feed the records from the storage sys-

tem to the turntable. For example, in all systems like that shown in Fig. 21, the record must slide under the guide trigger. A thick record may not be able to feed through here. On the other hand, if two very thin records get together, they may both try to feed through. The result could be a jamming on the shelf, or they both may drop at once. In the case of the thick record, of course, jamming results.

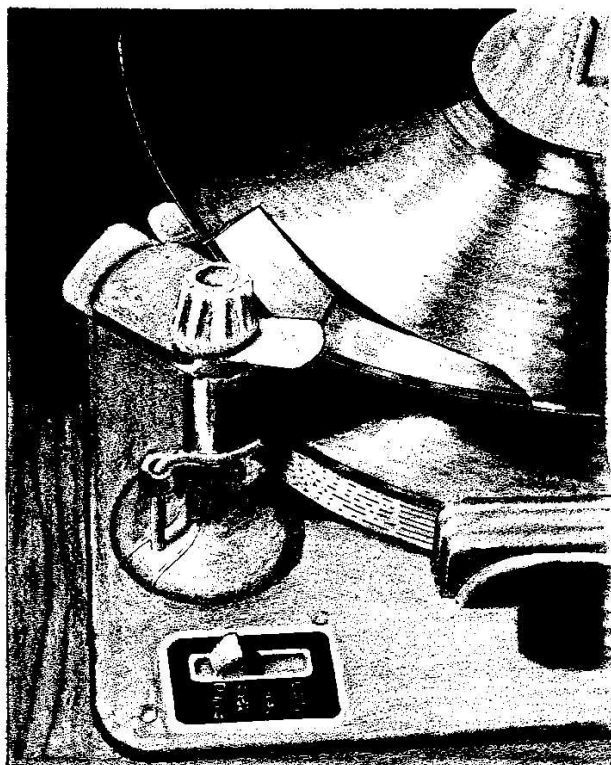


FIG. 32. An off-size record or improperly adjusted separating knives may result in record breakage like this.

In a changer that uses separating knives, records that are too thick or too thin may not be properly separated by the knives. If the record is too thick, the knives may cut into it instead of passing over it. If it is too thin, the knives may cut into the record above the one to be separated. Incidentally, rough or chipped record edges can also cause trouble by catching the knives. Fig. 32 shows an example of what may happen in such a case. Of course, this can also be the result of an improperly adjusted knife.

Improper Diameter. If the record is too large or too small in diameter, it may not feed through the storage mechanism properly, and naturally the pickup arm will not land properly on the record. Of course, a record that is off standard size this way is usually easy to detect because it can be directly compared with others in the stack. It is less easy to detect records that are thick or thin.

JAMMING

When a record changer is jammed, it is not advisable to try to force it to continue its changing cycle. Of course, just what is wrong depends upon whether the jam was caused by a defective part or by someone's trying to force the mechanism. In general, however, it is possible to clear jamming by rotating the turntable backwards. Of course the power must be shut off when you rotate the turntable by hand in this manner.

If the changer has a damaged part, it will jam at the same point in its cycle each time. In such a case you can rotate the turntable in the proper direction, by hand, until the jam occurs. You will then be better able to see just what has gone wrong.

Incidentally, it is possible for jamming to occur because the changer is not level or because it has shifted in its position in the cabinet. It may be that all the levers and gears originally cleared the interior of the cabinet but that a shift in position has permitted some lever to strike the cabinet. You can check the levelness of the changer with a carpenter's level.

GENERAL DEFECTS

Ordinarily, a changer is in need of repair because of the normal wear of some of the parts in it. This wear may be of such nature that an adjust-

ment, provided by the manufacturer, can clear up the difficulty. However, once a bearing becomes so loose that the lengths or positions of levers vary during the changing cycle, it will be necessary to make a major repair or to replace the changer.

Another common source of trouble is fatigue in the springs, of which changers have many. With use, these springs will eventually stretch so that they do not provide the proper tensions. When this happens, it is usually necessary to replace the offending spring; once in a while, however, you may find that the manufacturer has provided an adjustment for the spring by attaching one end of it to a movable terminal.

Incidentally, much of the trouble that is encountered with record changers comes about because of lack of proper oiling. Although oiling instructions usually accompany a changer, few owners remember to follow them—perhaps because the necessary oilings

are infrequent and therefore easily forgotten.

The manufacturer's instructions should be consulted when it is discovered that oiling is needed. It is usually safe to oil any metal-to-metal bearing, although often a light grease is indicated instead of regular oil.

There are some spots about a record changer that should *never* be oiled. Certain tripping mechanisms that depend upon friction may or may not require oiling, depending upon the materials used in them. For example, one changer has a cork washer to provide friction. Oil on this washer completely upsets the operation of the trip mechanism.

Similarly, it is desirable to keep oil away from all rubber parts. Many drive mechanisms are friction types, using rubber-tired pulleys. It is important to keep oil away from the rubber, but nevertheless to oil the bearings of such pulleys.

Pickups and Their Servicing

The pickup device itself has nothing to do with the automatic record changer other than the reproduction of the recording as an electrical signal. Nevertheless, when the output from a changer is distorted or sounds tinny or when there is no output at all, the serviceman is certain to get a call.

There are three types of pickups in common use today—the crystal, the magnetic, and a variable reluctance

type of magnetic pickup. Let's study their operation briefly.

As you know, all standard recordings used in the home are the result of modulating a groove so that it has "wiggles" from side to side in it. The record player needle fits in this groove and is forced to follow the variations. To reproduce the recorded sound, we have to have some means of translating this mechanical side-to-side motion of the needle tip into an electric signal.

Crystal Pickups. Probably the most widely used pickup today is one containing a crystal element. These units are inexpensive, easy to replace, and give a high output.

Fig. 33 shows the operating details of a crystal cartridge or pickup. The

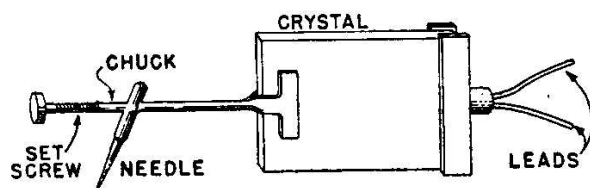
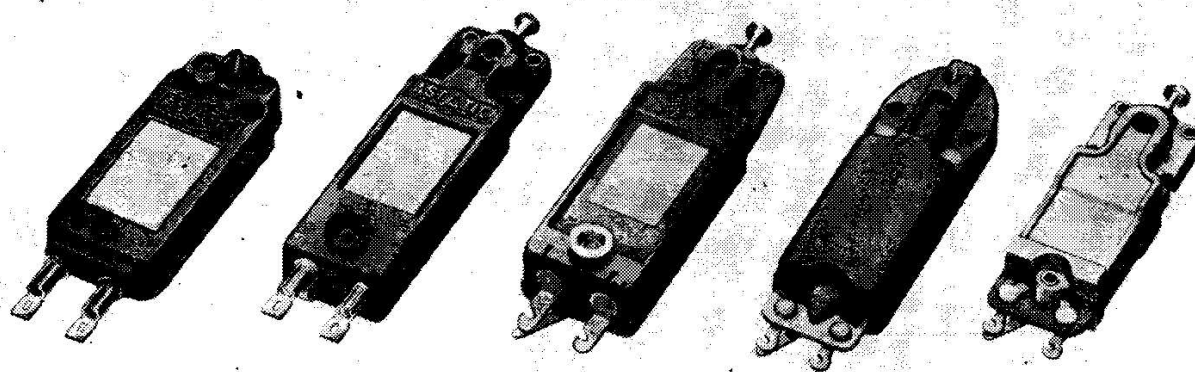


FIG. 33. Details of a crystal cartridge.



Courtesy Astatic Corp.

FIG. 34. Several typical crystal cartridges. They vary in physical size, method of connecting leads, and whether or not permanent needles are used. Some have greater outputs, and others offer better fidelity.

phonograph needle is held in a chuck by a screw. In turn, the chuck is clamped to one end of the crystal element. The opposite end of the crystal is mounted in the case so that it cannot move. Now, as the record grooves force the needle to move from side to side, the chuck is twisted. This twists the end of the crystal, applying a mechanical stress to it that causes it to generate a voltage, which appears on its opposite faces. Foil plates on the crystal surfaces pick up the voltage and feed it through the leads.

The physical appearance of crystal cartridges vary somewhat, as shown by several typical ones in Fig. 34. However, they all operate on basically the same principle—the only differences are in the housings, the methods of connecting the cable to the cartridge unit, and the styles of needle mountings. We shall go into needles a little later.

Magnetic Pickups. Fig. 35 shows the details of the operation of a magnetic pickup. Essentially, this consists of a permanent magnet, a coil, and an armature that can be actuated by the phonograph needle. As shown in this figure, motion of the needle from side to side directs the flux in opposite directions through the armature. Therefore, since the coil is essentially around

the armature, the flux variations in the armature cause voltages to be induced in the coil.

Variable Reluctance Pickup. The variable reluctance pickup, a typical example of which is shown in Fig. 36, is a variation of the magnetic type. However, the difference in the amount of needle pressure needed is appreciable. A magnetic head must be heavy

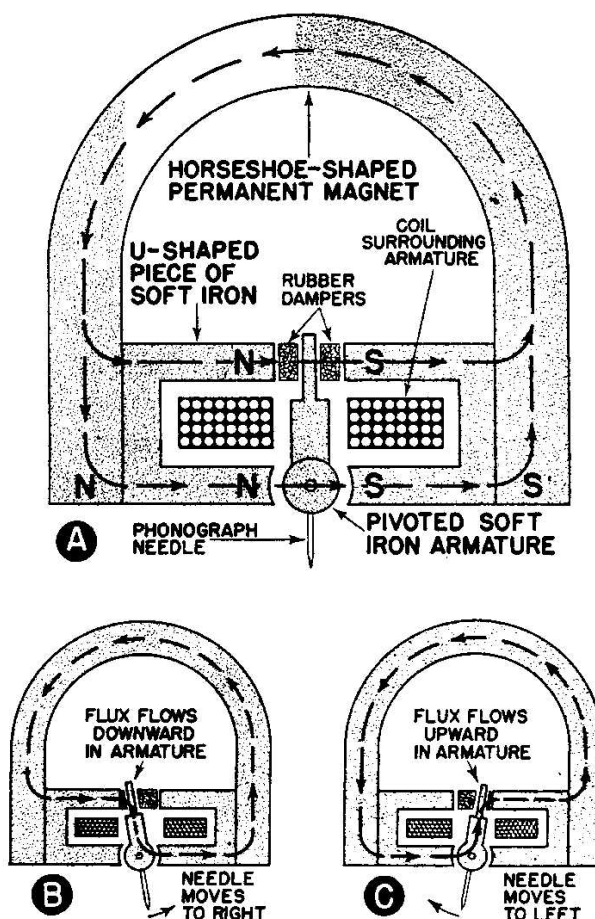


FIG. 35. Details of a magnetic pickup.

so that the head will not vibrate when the armature does; consequently, it presses rather heavily on a record and wears it out quickly. In the variable reluctance pickup, however, the vibrating device is a very tiny, lightweight reed; consequently, the head can be

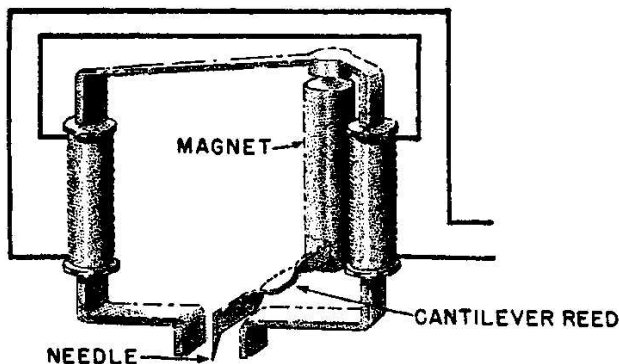


FIG. 36. One type of variable reluctance pickup.

made light enough to cause practically no record wear.

This change in weight comes about because the coil no longer picks up the flux variations directly from the armature. Instead, the armature in the variable reluctance type merely varies the reluctance in a magnetic path, and the coil picks up its energy from the variations in flux in this path.

As Fig. 36 shows, there are two paths for magnetic flux in this pickup. In each path, flux flows from the magnet through half of the pickup coil and through the reed back to the magnet. The position of the vibrating reed in the air space between the two coil cores determines how much flux flows in each half of the coil at any instant. When the reed is near one of the cores, the flux through the half of the coil wound around the other core decreases. The two halves of the coil are wound in opposite directions around their cores, however, so a decrease in flux through one has the same effect as an increase in flux through the other. This doubles the effect of the movement of the reed in producing a signal.

PICKUP DEFECTS

Crystal Pickup. A crystal cartridge is rather easily damaged. If the pick-up head is ever dropped, it is quite likely that the crystal will be cracked. Excessive motions of the needle may also crack the crystal. Moisture can also destroy a crystal. So can heat: a crystal should never be allowed to get hotter than 110° . Many pickups are ruined because the head is allowed to remain so long in the path of sunshine streaming in a window that the crystal becomes overheated.

A defect in the crystal practically always shows up as a severe distortion accompanied by weak volume. When you find a changer with such characteristics and have determined that the audio amplifier is not at fault, it is advisable to replace the crystal. Generally, the crystal is held in the pick-up arm by two screws or by a simple clamp arrangement. Simply remove the defective unit and install a good one of the same type in its place.

When you replace a crystal, be careful not to overheat the terminals if you must solder a cable to the cartridge. Excessive heat from the soldering iron will destroy the crystal. Therefore, it is best to have the pickup cable terminals well tinned and coated with solder so that you can sweat the cable end to the crystal terminals quickly.

Magnetic Pickup. The armature of a magnetic pickup sometimes strikes the pole pieces, either because the rubber damping blocks have worn out or because the armature has shifted its position. When this happens, the device will chatter, and the output will be severely reduced. Occasionally an armature moves over far enough to stick to one of the pole pieces by magnetic attraction. When this happens, of course there will be practically no out-

put. No output may also be the result of an open coil.

It is impractical to repair the pickup; the only thing to do is to replace the head when you are sure it is at fault.

Incidentally, with any type of pickup, it is well to be cautious about the cable that connects the pickup electrically to the amplifier. The cable almost always consists of a center wire surrounded by insulation, which is surrounded in turn by a braided shield that is grounded to prevent hum pickup. This shield is one of the conductors. Rather often the insulation between the center conductor and the shield wears through, permitting the cable to short. This is particularly likely to occur at the point in the cable where it leaves the end of the pickup arm and goes down underneath the motorboard. The moving of the arm back and forth twists and untwists the cable at this point so that the insulation may be mechanically worn out. It is well to examine and check cables for both opens and short circuits before condemning the pickup.

The position of this cable is such that oil may get on it if anyone is careless in oiling surrounding parts of the changer. This will speedily destroy the rubber insulation, permitting the cable to short-circuit. Naturally, this will reduce or kill the output.

PHONOGRAPH NEEDLES

As you will realize, it is desirable for a needle to be as permanent as possible. If the needle wears excessively, it may not even be able to play a stack of records. This is particularly true of some of the non-metallic needles, such as the thorn or cactus types.

Needles should be made so that they fit the grooves of the record. If the

needle point is too small, as shown in Fig. 37A, it can skid from side to side in the groove and thus introduce false frequencies. It may even ride out of the groove in such cases. In addition, a narrow needle may strike the bottom

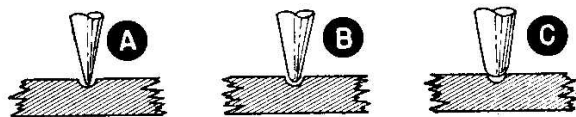


FIG. 37. Effects of needle-point sizes.

of the groove and pick up a great deal of noise from the imperfections there.

On the other hand, if the point is too broad, as shown in Fig. 37C, it cannot fit down into the groove and will tend to escape and permit the pickup head to slide across the record. When the needle fits the groove properly (Fig. 37B), it will follow the modulations in the record grooves without introducing other frequencies and without escaping from the grooves.

The harder the needle point, the more important it is that it have the correct needle shape initially. Unless a hard point is made with extreme care, it may have imperfections that will wear down the walls of the record groove and so destroy the fidelity of the recording.

The standard steel needle is usually only an approximation of the right shape. However, it is made of a material sufficiently soft so that the abrasive contained in a standard record will quickly wear the needle down until it fits the groove reasonably well. This wearing causes shoulders to build up on the needle, however, soon shaping it so that it can damage records. For this reason, a standard steel needle should be replaced each time a record is to be played. Obviously, this makes such needles rather impractical for record changers.

Longer playing steel needles are

made for record players. These needles are tipped with alloys that make the tips very hard. Then the needles are carefully selected so only those having the correct shape are sold. For permanent-point needles, it is well to remember that it is a good idea to buy those made by a reliable manufacturer. Any imperfections will remain for the life of the point and will cause wear of the record grooves. Most such points are shadowgraphed by the manufacturer, which means that an enlarged shadow of the needle point is thrown upon a screen for examination. Any needle with an imperfection is rejected.

In addition to the steel needles, there are available needles tipped with sapphire or diamond. These are the longest playing of all. Of course, these needles are rather expensive; if handled carefully, however, they will last for many thousands of playings.

The standard needle is straight and has a relatively thick shank. The more rigid the shank of the needle, the better it will transmit high audio frequencies—including scratch noises. Many people find the elimination of the scratch more desirable than good fidelity; to do this, some needles are made thin and flexible; others are coated with paint; and, finally, many actually have a bend or knee in them. All of these changes in the basic shape of the needle result in a reduction of the high-frequency response and a corresponding reduction in scratch noise.

Most modern record changers have permanent built-in needles. If anything is wrong with the needle, the entire pickup cartridge must usually be replaced. There are a few exceptions in which it is possible to replace the needle, however.

One exception is shown in Fig. 38.

This is a view of a cartridge used on certain RCA changers. The sapphire playing tip is held in a tiny socket by rubber cement (such as Goodrich Plasticon). If this needle needs replacement, it may be grasped firmly with a pair of tweezers, given a few turns to loosen the cement, and then pulled out.

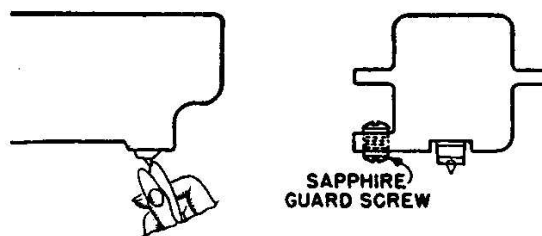


FIG. 38. How to replace the sapphire tip on certain RCA changers.

A new sapphire can be re-inserted, with just a drop of the rubber cement on it to hold it in the socket.

RECORD CARE

Many people do not know how to take proper care of their records. Whenever you find that the record collection of one of your customers is not in good condition, you can do him a service and create some good will for yourself by passing along these hints:

Records will become noisy if they are allowed to collect dust. They must be kept clean. It is best to store records in their original envelopes or albums, and then, if they do collect some dust, to brush them with a record brush.

It is necessary to store records properly to prevent them from warping. As you have learned, a warped record can easily get into trouble with the changer mechanism, because it may be impossible for the mechanism to separate warped records. Records should never be left resting on the support shelf of a record changer for a long time. They should always be stored carefully.

Motors and Their Servicing

The motors used on record players and changers must maintain their speeds accurately. The two basic motor types used in record changers—the synchronous motor and the induction motor using a governor—meet this requirement.

There are several forms of the synchronous motor. Most of them are of the eddy current type, but you will occasionally encounter shaded-pole or capacitor motors. Any of these are relatively constant in speed as long as they are not overloaded.

In general, little goes wrong with the motor itself as long as it is oiled properly. Once in a great while, you may find a changer in which the motor has a burned-out winding, but this is very rare. More commonly, any trouble will be with something related to the motor—the on-off switch may be defective or the motor may be overloaded. On the induction types, the speed governor may cause trouble.

A simplified drawing of a typical speed governor is shown in Fig. 39. This device contains a shaft that is coupled to the motor. Two weights are connected by springs to a collar on the end of the shaft. A wheel is also connected to the weights by springs. Let's see how the device works.

As the shaft rotates, the weights are thrown outward by centrifugal force. The pull exerted on the springs by the outward movement of the weights

pulls the wheel to the right, bringing it up against two friction pads made of felt. As soon as the wheel strikes the friction pads, it is slowed down by the friction; since the wheel is connected to the shaft through the springs and collar, the shaft is slowed down also. Thus, the motor is retarded if it attempts to run faster than the speed for which the governor is set. This keeps the motor running at a fairly constant speed as long as nothing happens to make it run too slowly; the governor has no action that will speed up a slow motor. The speed at which the governor will start to slow down the motor can be adjusted by moving the friction pads toward or away from the collar; the farther they are from the collar, the slower the speed at which the governor acts.

These governors will not maintain the speed properly if the friction pads wear down or become hard because of a lack of oiling. Watch for this if the speed is uneven.

DRIVE MECHANISMS

The driving force of a phonograph motor is applied to the turntable either at the center spindle or at the rim. Fig. 40 shows one form of spindle drive, in which the motor drives a gear mounted on a shaft secured to the spindle.

When the center spindle is driven this way, considerable power is needed to get the turntable started. Once started, however, the inertia of the rotating mass of the turntable tends to keep it going.

Many changers use a less powerful motor and drive the turntable from its rim. In systems of this kind, as shown in Fig. 41, the motor turns a small

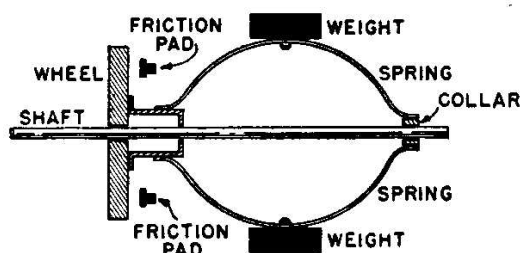


FIG. 39. Details of a typical speed governor.

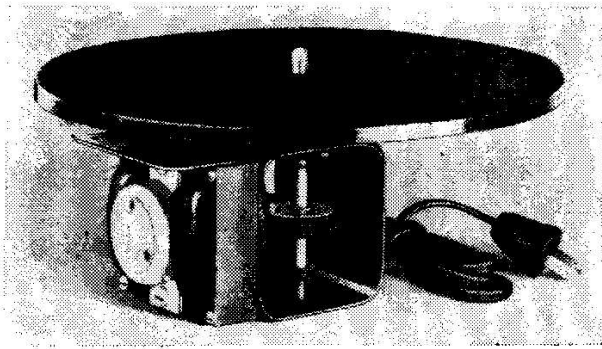


FIG. 40. A drive system that operates through the center spindle. This photo shows a record player; a changer would use a different spindle and would have the changer mechanism. These are omitted here to show the drive more clearly.

drive pulley. This is held against the rubber-tired idler pulley, the edge of which is against the rim of the turntable. Incidentally, it is necessary to use either gearing or an idler pulley system of this kind so that the motor can turn at a fair rate of speed, yet maintain the standard 78 revolutions per minute for the turntable.

There is another advantage to the rim drive system. In a center spindle drive, the motor is more or less directly connected through a gearing system to the turntable. Vibrations produced by

the motor can travel to the turntable and be picked up by the pickup. On the other hand, with the rim drive system, the motor can be flexibly mounted in a spring suspension. Springs keep its pulley in contact with the idler pulley. With this arrangement, any variation up or down in the drive pulley does not transfer any motion through the idler pulley to the turntable.

Spring suspension of the motor is important to keep down what is called turntable rumble, a frequent cause of customer complaints. This noise consists of a low-frequency rumbling sound, somewhat similar to hum, that can be heard only when the record is being played. Generally you will find it is caused by the fact that the motor is no longer suspended on springs—someone may have tightened the mounting so much that the springs are no longer effective, or they may be weakened so that the motor can jar the motorboard and, through it, the turntable. Sometimes this condition is made worse by the fact that the entire

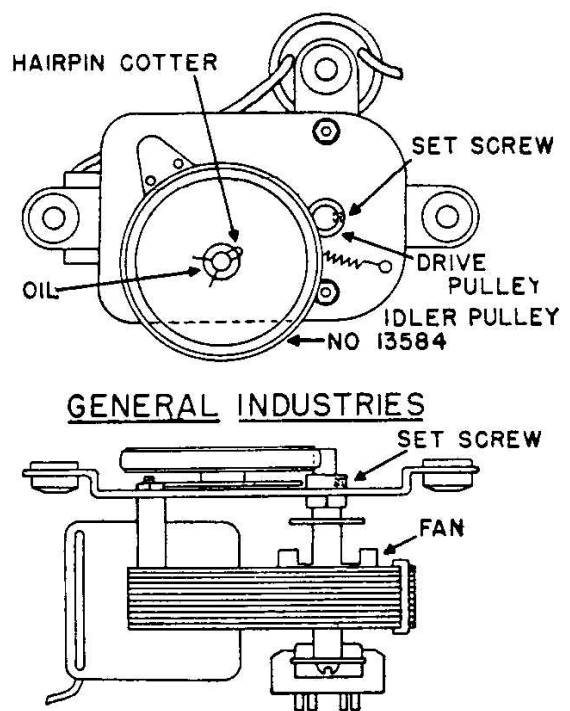
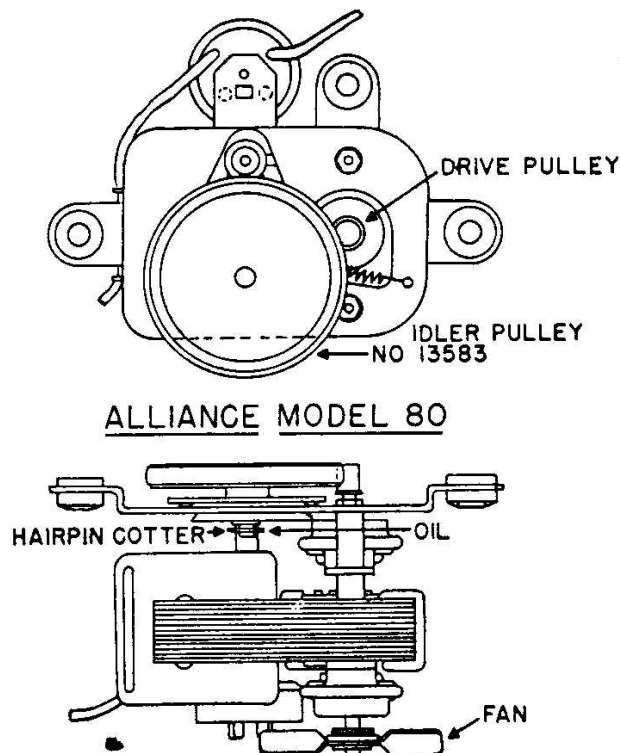
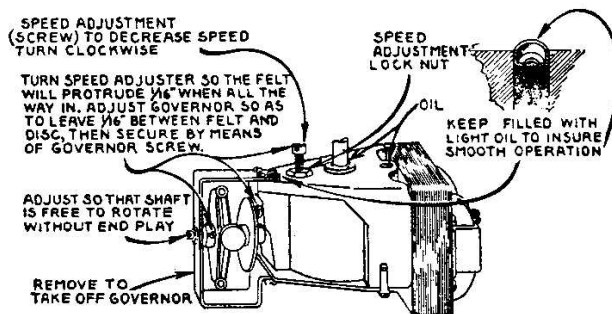


FIG. 41. Details of rim-drive systems.

motorboard is not sufficiently spring-mounted, either because someone has screwed down the changer too tightly to the cabinet or because it has shifted in position so that the motorboard is bearing against the cabinet wall. Sometimes flexible couplings are used between the motor drive and the rest of the drive mechanism to cut down some of this transfer of noise.

Improper speed is perhaps the most common complaint involving the motor system and drive mechanism. A synchronous motor never runs too fast, but it may run too slowly if the motor or the changer mechanism needs lubrication. Usually, careful oiling and greasing will clear up a trouble of this kind.

An induction-type motor that has a governor usually also has an adjusting screw by which the speed of the motor can be changed. A typical example is shown in Fig. 42. To get the motor to the right speed, a stroboscopic disc is placed on the turntable. This is a disc having a special pattern on it; when the disc is observed under a light operated from 60-cycle power, the pattern will apparently stand still if the motor is turning at the proper speed but will appear to revolve if the motor is going too fast or too slow. The proper turntable speed is secured, therefore, by



Courtesy RCA

FIG. 42. Certain RCA changers have speed adjustments as shown here.

turning the adjustment screw until the pattern appears to be motionless. These discs are available from radio supply houses and from many record dealers.

Remember that improper line voltages or variations in line voltage may affect the speed of the motor. Of course, if any foreign particles have lodged between the armature and the field pole pieces, or in any of the gearing, the motor may vary in speed or may even jam and not run at all.

Overheating is another motor trouble. This of course can be the result of insufficient lubrication, but may also be the result of bearings that are too tight, of short-circuited coils in the motor, or of an excessive load on the motor, such as may be produced by improper lubrication of the drive mechanism or by off-center mounting.

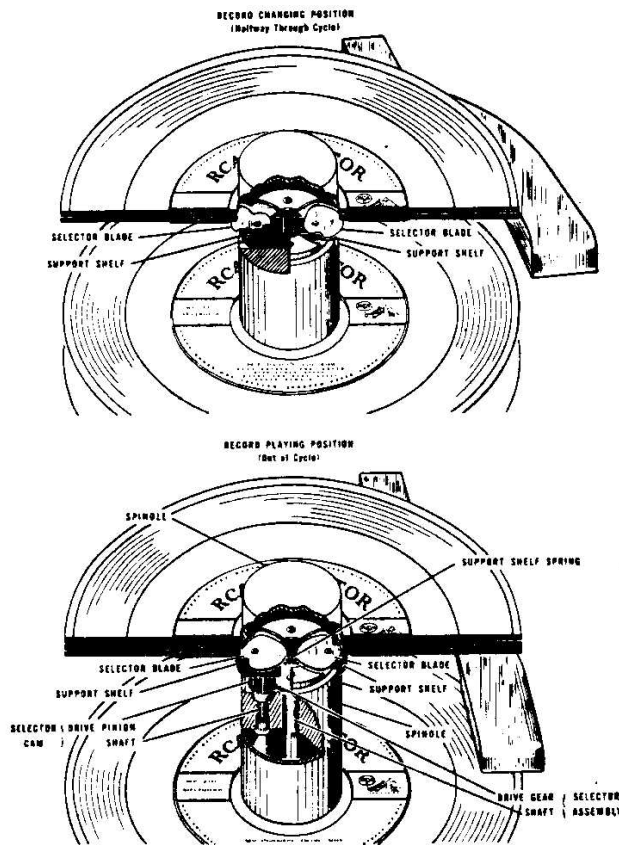
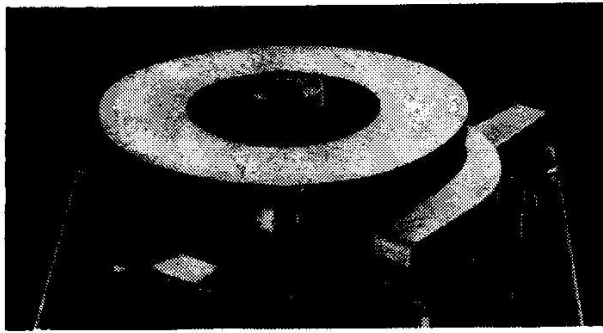
Microgroove Records

Recently there have been introduced two different series of records having very fine grooves (generally called microgrooves because of their thinness); these records are intended to rotate at slower speeds than 78 r.p.m.

LP Records. One microgroove type consists of 10-inch and 12-inch records designed to be played at 33 $\frac{1}{3}$ r.p.m. The slower speed and increased

number of grooves permit these records to hold much more recorded material; it is possible to get an entire symphony on both sides of one 12-inch record, whereas four to eight standard records would be needed for the same symphony.

The advantages of such a long-playing record are obvious—one no longer has to put up with the unnatu-



Courtesy RCA

Fig. 43. A photo and two sketches of the player designed for 45 r.p.m. microgroove records. The upper sketch shows how the separator knives move in between records while the support shelves are withdrawn simultaneously to allow the bottom record to drop. In the lower sketch, the support shelves now hold the record stack and the knives are withdrawn into the spindle.

ral break in the music that occurs when a record is changed in a conventional changer.

Both single-record players and changers designed only for these LP

(long-playing) records have been developed. Of course, the new speed requires a change in gearing or size of idler pulley, and the fine record groove requires a special fine-tipped needle and light-weight tone arm.

Combination changers can handle both the LP and the standard records (as long as they are not intermixed) by having a switch to change the turntable speed, and either using separate tone arms or a switching arrangement that will change the arm weight and needle size. The latter is obtained generally by using a dual needle and a tilting or revolvable crystal so that the proper tip is put into play. However, there is a new 7-inch microgroove record for popular music; this requires an additional switch to set the pick-up arm landing position, plus an extension spindle or platform to provide proper storage support for this small-size record.

45-R.P.M. Type. Another microgroove system uses a record $6\frac{7}{8}$ inches in diameter and a turntable speed of 45 r.p.m. These records are radically different in that they are designed to operate on a changer having the "works" in the center post. Hence, the records have a center hole $1\frac{1}{2}$ inches in diameter, and are made thicker in the label area to provide a space for the separating knives.

These records were introduced along with the unique changer shown in Fig. 43, but some of the recent changers will handle not only these records, but also the LP and standard ones by having interchangeable center spindles, three speeds, dual needles, and a new landing position for the tone arm.

Lesson Questions

Be sure to number your Answer Sheet 48RH-2.

Place your Student Number on every Answer Sheet.

Send in your set of answers for this Lesson immediately after you finish them, as instructed in the Study Schedule. This will give you the greatest possible benefit from our speedy personal grading service.

1. What feature is provided on standard records to make it possible for the changer mechanism to regain control after the record has finished playing?

The secondary groove step is placed near the center hole on the record.

2. What are the three main types of trip mechanisms?

The eccentric trip, the positional trip, and the velocity trip.

3. What is the function of the main cam in most record changers?

To control the sequence of operations.

4. In the elevator system shown in Fig. 12A, how would you adjust for the condition wherein the pickup arm is not lifted sufficiently to play a record on top of a stack?

The screw points on the frame must be turned.

5. What is the function of the guide trigger in the spindle of a single-post changer?

To force the record into a position to be caught by the edge of the spindle.

6. What is the function of the knives in a 2-post or 3-post changer?

To separate the bottom record from the rest so it can be dropped by itself.

7. What two things can happen if the pickup arm is moved when a changer is in cycle?

The record may be jammed or it may be scratched.

8. What precaution must be taken when replacing a crystal pickup?

The crystal must not be heated when soldering the leads.

9. Why should one be careful to keep oil off the electrical cable that connects the pickup to the amplifier?

The cable has rubber insulation and oil will rot the rubber allowing the wire to short.

10. What two things may cause a governor-controlled motor to run unevenly?

The governor may be out of adjustment or the system may need oil.